MANUAL OF AMERICAN GRAPE-GROWING

Hedrick

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MANUAL OF AMERICAN GRAPE-GROWING

BY
U. P. HEDRICK
HORTICULTURIST OF THE NEW YORK AGRICULTURAL EXPERIMENT STATION

New York
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PREFACE

SEVENTY-NINE books on grapes enrich the pomology of North America, not counting numerous state and national publications. Pomological writers in America have been partial to the grape, for other fruits do not fare nearly so well. Twenty-two books are devoted to the strawberry, fourteen to the apple, to the peach nine, cranberry eight, plum five, pear nine, quince two, loganberry one, while the cherry, raspberry, and blackberry are not once separated from other fruits in special books. Thus, though a comparative newcomer among the fruits of the country, the grape has been singled out for a treatise more times than all other fruits of temperate climates combined — seventy-nine books on the grape, seventy on all other fruits.

This statement of partiality does not lead to an apology for a new book on the grape. There is urgent need for a new book. But three of the seventy-nine treatises on this fruit are contemporary, and all but one, a handbook on training, are records from vanished minds. Methods change so rapidly and varieties multiply so fast, that to keep pace there must be new books on fruits every few years. Besides, the types of grapes are so diverse, and different soils, climates, and treatments produce such widely dissimilar results, that many books are required to do justice to this fruit — the vineyard should be seen through many eyes.

Commercial grape-growing is now a great industry in America, and deserves a treatise of its own. But there are also many demands for information on grape-growing by those who grow fruits for pleasure, especially by those who are escaping from

cities to suburban homes, for the grape is a favorite fruit of the amateur. And so, though Pleasure and Profit are a hard team to drive together, this manual is written for both commercial and amateur grape-growers.

In particular, the needs of the amateur are recognized in the chapter on varieties, where many sorts are described which have little or no commercial value. No other fruit offers the enchantment of novelty to be found in the grape. Alluring flavors, sizes, and colors abound, of which the amateur wants samples. The commercial grower who plants but one variety often finds himself dissatisfied with the humdrum of the business. He should emulate the amateur and plant more kinds, if only for pleasure, remembering the adage, "No profit grows where is no pleasure ta'en." Greater pleasure in grape-growing, then, is offered as the justification of the long chapter on varieties.

At the risk of too broad spreading, the author discusses, in a book mainly devoted to native grapes, the culture of European grapes in the far West. The chief aim is, of course, to set forth information that will be helpful to growers of these grapes in the western states, there being no treatises to which western growers can refer, other than bulletins from state and national agricultural institutions. There is, however, another reason for attempting to cover the whole field of grape-growing in America. It is certain that eastern grape-growers will sometime grow European grapes. Western vineyards might well be enlarged with plantings of native grapes. On the supposition, then, that the culture of both European and native grapes is to become less and less restricted in America, the author has ventured to discuss the culture of all grapes for all parts of North America.

In the preparation of this manual, the author's "The Grapes of New York," a book long out of print and never widely distributed, has been laid under heavy contribution, especially

in the description of varieties. Acknowledgments are due to F. Z. Hartzell for reading the chapter on Grape Pests and their Control and for furnishing most of the photographs used in making illustrations of insects and fungi; to F. E. Gladwin for similar help in preparing the two chapters on pruning and training the grape in eastern America; to Frederic T. Bioletti for permission to republish from a bulletin written by him from the Agricultural Experiment Station of California almost the whole chapter on Grape Pruning on the Pacific Slope; and to O. M. Taylor and to R. D. Anthony for very material assistance in reading the manuscript and proofs.

U. P. Hedrick.

Geneva, N. Y.,
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MANUAL OF AMERICAN GRAPE-GROWING

CHAPTER I

THE DOMESTICATION OF THE GRAPE

The domestication of an animal or a plant is a milestone in the advance of agriculture and so becomes of interest to every human being. But, more particularly, the materials, the events and the men who direct the work of domestication are of interest to those who breed and care for animals and plants; the grape-grower should find much profit in the story of the domestication of the grape. What was the raw material of a fruit known since the beginning of agriculture and wherever temperate fruits are grown? How has this material been fashioned into use? Who were the originative and who the directive agents? These are fundamental questions in the improvement of the grape, answers to which will also throw much light on the culture of it.

Botanists number from forty to sixty species of grapes in the world. These are widely distributed in the northern hemisphere, all but a few being found in temperate countries. Thus, more than half of the named species come from the United States and Canada, while nearly all of the others are from China and Japan, with but one species certainly growing wild in southwestern Asia and bordering parts of Europe. All true grapes have more or less edible fruits, and of the twenty or more species grown in the New World more than half have been or are being domesticated. Of the Old World grapes, only one

species is cultivated for fruit, but this, of all grapes, is of greatest economic importance and, therefore, deserves first consideration.

The European Grape

The European grape, *Vitis vinifera* (Fig. 1), is the grape of ancient and modern agriculture. It is the vine which Noah planted after the Deluge; the vine of Israel and of the Promised Land; the vine of the parables in the New Testament. It is the grape and the vine of the myths, fables, poetry and prose of all peoples. It is the grape from which the wines of the world are made. From it come the raisins of the world. It is the chief agricultural crop of southern Europe and northern Africa and of vast regions in other parts of the world, having followed civilized man from place to place in all temperate climates. The European grape has so impressed itself on the human mind that when one thinks or speaks of the grape, or of the vine, it is this Old World species, the vine of antiquity, that presents itself.

The written records of the cultivation of the European grape go back five or six thousand years. The ancient Egyptians, Phœnicians, Greeks and Romans grew the vine and made wine from its fruit. Grape seeds have been found in the remains of European peoples of prehistoric times, showing that primitive men enlivened their scanty fare with wild grapes. Cultivation of the grape in the Old World probably began in the region about the Caspian Sea where the vine has always run wild. We have proof of the great antiquity of the grape in Egypt, for its seeds are found entombed with the oldest mummies. Probably the Phœnicians, the earliest navigators on the Mediterranean, carried the grape from Egypt and Syria to Greece, Rome and other countries bordering on this sea. The domestication of the grape was far advanced in Christ's time, for Pliny, writing then, describes ninety-one kinds of grapes and fifty kinds of wine.

It can never be known exactly when the European grape came under cultivation. There is no word as to what were the methods and processes of domestication, and whose the minds and hands that remodeled the wild grape of Europe into the

FIG. 1. A shoot of *Vitis vinifera*.

grape of the vineyards. The Old World grape was domesticated long before the faint traditions which have been transmitted to our day could possibly have arisen. For knowledge of how wild species of this fruit have been and may be brought under cultivation, we must turn to New World records.

American Grapes

Few other plants in the New World grow wild under such varied conditions and over such extended areas as the grape. Wild grapes are found in the warmer parts of New Brunswick; on the shores of the Great Lakes; everywhere in the woodlands of the North and Middle Atlantic states; on the limestone soils of Kentucky, Tennessee and the Virginias; and they thrive in the sandy woods, sea plains and reef-keys of the South Atlantic and Gulf states. While not so common west of the Mississippi, yet some kind of wild grape is found from North Dakota to Texas; grapes grow on the mountains and in the cañons of all the Rocky Mountain states; and several species thrive on the Mexican borders and in the far Southwest.

While it is possible that all American grapes have descended from an original species, the types are now as diverse as the regions they inhabit. The wild grapes of the forests have long slender trunks and branches, whereby their leaves are better exposed to the sunlight. Two shrubby species do not attain a greater height than four or five feet; these grow in sandy soils, or among rocks exposed to sun and air. Another runs on the ground and bears foliage almost evergreen. The stem of one species attains a diameter of a foot, bearing its foliage in a great canopy. From this giant form the species vary to slender, graceful, climbing vines. Wild grapes are as varied in climatic adaptations as in structure of vine and grow luxuriantly in every condition of heat or cold, wetness or dryness, capable of supporting fruit-culture in America. So

many of the kinds have horticultural possibilities that it seems certain that some grape can be domesticated in all of the agricultural regions of the country, their natural plasticity indicating, even if it were not known from experience, that all can be domesticated.

Leif the Lucky, the first European to visit America, if the Icelandic records are true, christened the new land Wineland. It has been supposed that this designation was given for the grapes, but recent investigations show that the fruits were probably mountain cranberries. Captain John Hawkins, who visited the Spanish settlements in Florida in 1565, mentions wild grapes among the resources of the New World. Amadas and Barlowe, sent out by Raleigh in 1584, describe the coasts of the Carolinas as, "so full of grapes that in all the world like abundance cannot be found." Captain John Smith, writing in 1606, describes the grapes of Virginia and recommends the culture of the vine as an industry for the newly founded colony. Few, indeed, are the explorers of the Atlantic seaboard who do not mention grapes among the plants of the country. Yet none saw intrinsic value in these wild vines. To the Europeans, the grapes of the Old World alone were worth cultivating, and the vines growing everywhere in America only suggested that the grape they had known across the sea might be grown in the new home.

That American viticulture must depend on the native species for its varieties began to be recognized at the beginning of the nineteenth century, when several large companies engaged in growing foreign grapes failed, and a meritorious native grape made its appearance. The vine of promise was a variety known as the Alexander. Thomas Jefferson, ever alert for the agricultural welfare of the nation, writing in 1809 to John Adlum, one of the first experimenters with an American species, voiced the sentiment of grape experimenters in speaking of the Alexander: "I think it will be well to push the culture

of this grape without losing time and efforts in the search of foreign vines, which it will take centuries to adapt to our soil and climate."

FIG. 2. A shoot of *Vitis Labrusca*.

Alexander is an offshoot of the common fox-grape, *Vitis Labrusca* (Fig. 2), found in the woods on the Atlantic coast from Maine to Georgia and occasionally in the Mississippi Valley. The history of the variety dates back to before the Revolutionary

War, when, according to William Bartram, the Quaker botanist, it was found growing in the vicinity of Philadelphia, by John Alexander, gardener to Governor Penn of Pennsylvania. Curiously enough, it came into general cultivation through the deception of a nurseryman. Peter Legaux, a French-American grape-grower, in 1801 sold the Kentucky Vineyard Society fifteen hundred grape cuttings which he said had been taken from an European grape introduced from the Cape of Good Hope, therefore called the "Cape" grape. Legaux's grape turned out to be the Alexander. In the new home the spurious Cape grew wonderfully well and as the knowledge of its fruitfulness in Kentucky, Ohio and Indiana spread, demand for it increased, and with remarkable rapidity, considering the time, it came into general cultivation in the parts of the United States then settled.

The Labrusca or fox-grapes.

Of the several species of American grapes now under cultivation, the Labrusca, first represented by the Alexander, has furnished more cultivated varieties than all the other American species together, no less than five hundred of its varieties having been grown in the vineyards of the country. There are several reasons why it is the most generally cultivated species. It is native to the parts of the United States in which agriculture soonest advanced to a state where fruits were desired. In the wild, the Labruscas are the most attractive, being largest and handsomest in color; among all grapes it alone shows black-, white- and red-fruited forms on wild vines. There is a northern and a southern form of the species, and its varieties are, therefore, widely adapted to climates and to soils. The flavor of the fruits of this species, all things considered, is rather better than that of any other of our wild grapes, though the skins in most of its varieties have a peculiar aroma, somewhat pronounced in the well-known Concord, Niagara and Worden,

which is disagreeable to tastes accustomed to the pure flavors of the European grapes. All Labruscas submit well to vineyard operations and are vigorous, hardy and productive, though they are more subject to the dreaded phylloxera than are most of the other cultivated native species. Of the many grapes of this type, at least two deserve brief historical mention.

Catawba, probably a pure-bred Labrusca, the first American grape of commercial importance, is the most interesting variety of its species. The origin of the variety is not certainly known, but all evidence points to its having been found about the year 1800 on the banks of the Catawba River, North Carolina. It was introduced into general cultivation by Major John Adlum, soldier of the Revolution, judge, surveyor and author of the first American book on grapes. Adlum maintained an experimental vineyard in the District of Columbia, whence in 1823 he began the distribution of the Catawba. At that time the center of American grape culture was about Cincinnati, and an early shipment of Adlum's Catawbas went to Nicholas Longworth of that city and was by him distributed throughout the grape-growing centers of the country. As one of the first to test new varieties of American grapes, to grow them largely and to make wine commercially from them, Nicholas Longworth is known as the "father of American grape culture."

Catawba is still one of the four leading varieties in the vineyards of eastern America. The characters whereby its high place is maintained among grapes are: Great elasticity of constitution, by reason of which the vine is adapted to many environments; rich flavor, long-keeping quality, and handsome appearance of fruit, qualities which make it a very good dessert grape; high sugar-content and a rich flavor of juice, so that from its fruit is made a very good wine and a very good grape-juice; and vigor, hardiness and productiveness of vine. The characters of Catawba are readily transmissible, and it

has many pure-bred or hybrid offspring which more or less resemble it.

The second commercial grape of importance in American viticulture is Concord, which came from the seed of a wild grape planted in the fall of 1843 by Ephraim W. Bull, Concord, Massachusetts. The new variety was disseminated in the spring of 1854, and from the time of its introduction the spread of its culture was phenomenal. By 1860 it was the leading grape in America and it so remains. Concord furnishes, with the varieties that have sprung from it, seventy-five per cent of the grapes grown in eastern America. The characters which distinguish the vine are: Adaptability to various soils, fruitfulness, hardiness and resistance to diseases and insects. The fruits are distinguished by certainty of maturity, attractive appearance, good but not high flavor, and by the fact that they may be produced so cheaply that no other grape can compete with this variety in the markets. Concord is, as Horace Greeley well denominated it in awarding the Greeley prize for the best American grape, "the grape for the millions."

The histories of these two grapes are typical of those of five hundred or more other Labruscas. Out of a prodigious number of native seedlings, an occasional one is found greatly to excel its fellows and is brought under cultivation.

The Rotundifolia or Muscadine grapes.

Long before the northern Labruscas had attained prominence in the vineyards of the North, a grape had been domesticated partially in the South. It is *Vitis rotundifolia* (Fig. 3), a species which runs riot from the Potomac to the Gulf, thriving in many diverse soils, but growing only in the southern climate and preferring the seacoast. Rotundifolia grapes have been cultivated somewhat for fruit or ornament from the earliest colonial times. It is certain that wine was made from this species by the English settlers at Jamestown. Vines of it are now to be

found on arbors, in gardens or half wild on fences in nearly every farm in the South Atlantic states. That the Rotundifolias have not been more generally brought under cultivation is due

FIG. 3. A shoot of *Vitis rotundifolia*.

to the bountifulness of the wild vines, which has obviated the necessity of domesticating them. The fruit of its varieties, to a palate unaccustomed to them, is not very acceptable,

having a musky flavor and odor and a sweet, juicy pulp, which is lacking in sprightliness. Many, however, acquire a taste for these grapes and find them pleasant eating. The great defect of this grape is that the berries part from the pedicels as they ripen and perfect bunches cannot be secured. In fact, the crop is often harvested by shaking the vines so that the berries drop on sheets beneath. Despite these defects, a score or more varieties of this species are now under general cultivation in the cotton-belt, and interest in their domestication is now greater than in any other species, with great promise for the future.

The Æstivalis or summer-grapes.

The South has another grape of remarkable horticultural possibilities. This is *Vitis æstivalis* (Fig. 4), the summer-grape or, to distinguish it from the Rotundifolias, the bunch-grape of southern forests. There are now a score or more well-known varieties of this species, the best known being Norton, which probably originated with Dr. D. N. Norton, Richmond, Virginia, in the early part of the nineteenth century. The berries of the true Æstivalis grapes are too small, too destitute of pulp and too tart to make good dessert fruits, but from them are made our best native red wines. Domestication of this species has been greatly retarded by a peculiarity of the species which hinders its propagation. Grapes are best propagated from cuttings, but this species is not easily reproduced by this means and the difficulty of securing good young vines has been a serious handicap in its culture.

There are two subspecies of *Vitis æstivalis* which promise much for American viticulture. *Vitis æstivalis Bourquiniana*, known only under cultivation and of very doubtful botanical standing, furnishes American viticulture several valuable varieties. Chief of these is the Delaware, the introduction of which sixty years ago from the town of Delaware, Ohio,

raised the standard in quality of New World grapes to that of Old World. No European grape has a richer or more delicate flavor, or a more pleasing aroma, than Delaware. While a northern grape, it can be grown in the South, and thrives under

FIG. 4. A shoot of *Vitis æstivalis*.

so many different climatic and soil conditions and under all is so fruitful, that, next to the Concord, it is the most popular American grape for garden and vineyard. Without question, however, Delaware contains a trace of European blood.

Another offshoot of this subspecies is Herbemont, which, in the South, holds the same rank that Concord holds in the

North. The variety is grown only south of the Ohio, and in this great region it is esteemed by all for a dessert grape and for its light red wine. It is one of the few American varieties which finds favor in France, being cultivated in southwest France as a wine-grape. Its history goes back to a colony of French Huguenots in Georgia before the Revolutionary War. Very similar to Herbemont is Lenoir, also with a history tracing back to the French in the Carolinas or Georgia in the eighteenth century.

The other subspecies of *Vitis æstivalis* is *Vitis æstivalis Lincecumii,* the post-oak grape of Texas and of the southern part of the Mississippi Valley. Recently this wild grape has been brought under domestication, and from it has been bred a number of most promising varieties for hot and dry regions.

The Vulpina or river-bank grapes.

The North, too, has a wine-grape from which wines nearly equaling those of the southern Æstivalis are made. This is *Vitis vulpina* (*V. riparia*), the river-bank grape, a shoot of which is shown in Fig. 5, the most widely distributed of any of the native species. It grows as far north as Quebec, south to the Gulf of Mexico and from the Atlantic to the Rocky Mountains. Fully a century ago, a wine-grape of this species was cultivated under the name Worthington, but the attention of vineyardists was not turned to the Vulpinas until after the middle of the last century, when the qualities of its vines attracted the attention of French viticulturists. Phylloxera had been introduced from America into France and threatened the existence of French vineyards. After trying all possible remedies for the scourge, it was discovered that the insect could be overcome by grafting European grapes on American vines resistant to phylloxera. A trial of the promising species of New World grapes showed that vines of this species were best suited for the reconstruction of

French vineyards, the vines being not only resistant to the phylloxera but also vigorous and hardy. At present, a large proportion of the vines of Europe, California and other grape-growing regions are grafted on the roots of this or of other

FIG. 5. A shoot of *Vitis vulpina*.

PLATE I. — Two views of vineyards in California. *Top*, a vineyard in the orchard region of central California; *bottom*, a vineyard in southern California.

American species, and the viticulture of the world is thus largely dependent on these grapes.

The French found that a number of the Vulpina (Riparia) grapes introduced for their roots were valuable as direct producers for wines. The fruits of this species are too small and too sour for dessert, but they are free from the disagreeable tastes and aromas of some of our native grapes and, therefore, make very good wines. The best known of the varieties of this species is the Clinton, which is generally thought to have originated in the yard of Dr. Noyes, of Hamilton College, Clinton, New York, about 1820. It is, however, probably the Worthington, of which the origin is unknown, renamed. There are possibly a hundred or more grapes now under cultivation wholly or in part from Vulpina, most of them hybrids with the American Labrusca and the European Vinifera, with both of which it hybridizes freely.

Domesticated species of minor importance.

In the preceding paragraphs we have seen that four species of grapes constitute the foundation of American viticulture. Nine other species furnish pure-bred varieties and many hybrids with the four chief species or among themselves. These are *V. rupestris, V. Longii, V. Champinii, V. Munsoniana, V. cordifolia, V. candicans, V. bicolor, V. monticola* and *V. Berlandieri.* Several of these nine species are of value in the vineyard or for stocks upon which to graft other grapes. The domestication of all of these is just begun, and each year sees them more and more in use in the vineyards of the country.

CHAPTER II

GRAPE REGIONS AND THEIR DETERMINANTS

HAPPILY, the grape in its great diversity of forms accommodates itself to many conditions, so that some variety of the several cultivated species will produce fruit for home use, if not as a market commodity, in every part of America adapted to general agriculture. But commercial grape-growing on this continent is confined to a few regions, in each of which it is profitable only in ideal situations. In fact, few other agricultural industries are more definitely determined by environment than the grape-industry. Where are the grape regions of America? What determines the suitability of a region for grape-growing? Answers to these questions furnish clews to the culture of this fruit and help in estimating the potentialities of a new region or of a location for grape-growing.

THE GRAPE REGIONS OF AMERICA

There are four chief grape-growing regions in North America, with possibly twice as many more subsidiary ones. These several regions, each of which has its distinct varieties and to less extent distinct species, and in each of which grapes are grown for somewhat widely different purposes, give a great variety of industrial conditions to the grape-growing of the continent. Nevertheless, the regions have much in common in their environment. It is from their differences and similarities that most can be learned in the brief discussions of the regions that follow.

The Pacific slope.

The Pacific slope takes precedence among the grape regions of the continent, exceeding all others combined in the production of grapes and grape products. California is the viticultural center of this great region, grapes being grown within her bounds from the foot of Mount Shasta on the north to Mexico on the south and from the foothills of the Sierras on the east to the forest that borders the coast on the west. So outlined, California might appear to be one vast vineyard, but it is only in favored valleys, plains and low hills in the territory bounded that the vine is sufficiently well suited to be productive. Outliers of this main region of the Pacific slope run north into Oregon, Washington, Idaho and even into British Columbia, forced more and more eastward the farther north to escape humidity from the ocean which northward passes farther and farther inland. Other outliers of the main region are found eastward in Nevada, Arizona, New Mexico and even Utah and Colorado, though for the most part in these states grape-growing is still insignificant. Plate I. shows typical vineyards in California.

The grapes grown on the Pacific slope are almost exclusively Vinifera varieties, though a few American grapes are planted in the Pacific Northwest. This is not because American varieties cannot be grown, although they succeed rather less well here than on the eastern seaboard, but because the Viniferas are liked better, and climate and soil seem exactly to suit them. Viticulture on the Pacific slope is divided into three interdependent industries which are almost never quite independent of each other — the wine industry, raisin industry and table-grape industry. Each of these industries depends on grapes more or less specially adapted to the product, the special characteristics being secured chiefly through somewhat distinct types of grapes but depending partly on soil and climatic con-

ditions. The manufacture of unfermented grape-juice is not yet a success in this region for the reasons that Vinifera grapes do not make a good unfermented juice, and American grapes are not grown in sufficient quantities to warrant the establishment of grape-juice plants.

Bioletti gives the extent of the grape-growing industry in California as follows:[1]

"The vineyards of California covered in 1912 about 385,000 acres. Of this total, about 180,000 acres were producing wine-grapes. Roughly, 50 per cent of the wine was produced in the great interior valleys, including most of the sweet wines; 35 per cent was produced by the valleys and hillsides of the Coast ranges, including most of the dry wines; the remaining 15 per cent was produced in Southern California and included both sweet and dry.

"The raisin-grape vineyards covered about 130,000 acres, of which about 90 per cent were in the San Joaquin Valley, 7 per cent in the Sacramento, and 3 per cent in Southern California.

"The shipping-grape vineyards are reckoned at 75,000 acres, distributed about as follows: 50 per cent in the Sacramento Valley, 40 per cent in San Joaquin, 6 per cent in Southern California, and 4 per cent in the Coast ranges."

The Chautauqua grape-belt.

The Chautauqua grape-belt, lying along the northeastern shore of Lake Erie in New York, Pennsylvania and Ohio, is the second most important grape region in America. The "belt" is a narrow strip of lowland averaging about three miles in width, lying between Lake Erie and a high escarpment which bounds the belt on the south throughout its entire length of a hundred or more miles. Here climate and soil seem to be

[1] Bioletti, Frederic T. *Report of International Congress of Viticulture*, 88. 1915.

exceptionally favorable for grape-growing. Climate is the chief determinant of the boundaries of this belt, since there are several types of soil upon which grapes do equally well in the region, and when the climate changes at the two extremities of the belt where the escarpment becomes low, or when the distance between the lake and the escarpment is great, grape-growing ceases to be profitable.

The growers of this region are organized into selling associations so that estimates of acreage and yields are obtainable. At present writing, 1918, there are in this belt in New York about 35,000 acres of grapes; in Pennsylvania and Ohio, about 15,000 acres, much the greater part of which is in Pennsylvania. The average yield of grapes to the acre for the region is about two tons. The average total production for the past five years has been about 100,000 tons, of which 65,000 tons are shipped as table-grapes, and 35,000 tons are used in the manufacture of wine and grape-juice. Among varieties, Concord reigns supreme in the Chautauqua belt. The writer, in 1906, made a canvass of the region, vineyard by vineyard, and found that 90 per cent of the acreage of the belt was set to Concord, 3 per cent to Niagara, 2 per cent to Worden and the remaining 5 per cent to a dozen or more varieties of which Moore Early and Delaware led.

The manufacture of grape-juice on a commercial scale began in the Chautauqua belt and most of this product is still produced in the region. Here, only Concord grapes of the best quality are used for grape-juice. The growth of this industry is most significant for the future of grape-growing in the region. Twenty years ago grape-juice was a negligible factor in the grape industry of this region; at present, the annual output is in the neighborhood of 4,000,000 gallons. Grape-juice-makers now determine the price of grapes for the region, and while the quantity used is less than that for table-grapes, the time is not distant when it will be greater.

The Niagara region.

Fifty miles due north of the Chautauqua belt, across the end of Lake Erie and the narrow isthmus of Niagara, is a smaller belt on the southern shore of Lake Ontario so similar in soil, climate and topography that in these respects the two regions might be considered as identical. This is the Niagara region, Canada's chief grape-producing area. It is bounded on the north by Lake Ontario; on the south, at a distance of one to three miles by the high Niagara escarpment; to the east it crosses the Niagara River into New York; and in the west tapers to a point at Hamilton on the westward extremity of Lake Ontario. Here, again, is the influence of climate distinctly manifested. As this belt passes into New York, it widens and the influence of Lake Ontario is less and less felt to the eastward, and in consequence grape-growing becomes less and less profitable.

There were, according to the Ontario Bureau of Industries, in 1914, about 10,850 acres of grapes in the Niagara region in Canada, and possibly 4,000 acres more near the Niagara River and along the shore of Lake Ontario in New York. The Niagara grape originated on the American side of the Niagara region and is here planted more extensively than elsewhere. Grape-growing in this region is similar in all respects to that of the Chautauqua belt, the same varieties and nearly identical methods of pruning, cultivation, spraying and harvesting being employed. The crop is chiefly used as table-grapes but the grape-juice industry is growing.

The Central Lakes region of New York.

In the central part of western New York are several remarkable bodies of water known as the Central Lakes. Three of these are large and deep enough to give ideal climatic conditions for grapes, and about these lakes are grouped several im-

portant areas of vineyards, making this the third most important grape region in America. The region assumes further importance because most of the champagne made in America is produced here, and it is the chief center of still wines in eastern America as well. It is further distinguished by its distinctive types of grapes, Catawba and Delaware taking the place of Concord and Niagara, the sorts that usually predominate in eastern grape regions.

The main body of this region lies on the steep slopes of the high lands surrounding Keuka Lake. On the shores of this lake there are, approximately, 15,000 acres of grapes. Adjacent to this main body are several smaller bodies about the neighboring lakes. Thus, at the head of Canandaigua Lake and on its shores are about 2500 acres; near Seneca and between Seneca and Cayuga Lakes there are probably 1500 acres more. In a few specially favored places on other of these Central Lakes, there are possibly 1000 acres, making all told for this region, about 20,000 acres. Again it is climate that sets the seal of approval on the region for viticulture. In addition to the benefits of deep bodies of water, high and sloping lands cause the frosts to cease early in the spring and hold them in abeyance in the autumn, giving an exceptionally long season.

Champagne-making began here about 1860; at present there are a score or more manufacturers of champagne, wine and brandy, the output being annually about 3,000,000 gallons of wine and 2,000,000 bottles of champagne. Recently the manufacture of grape-juice has begun and the industry is now flourishing.

Minor grape regions.

Viticulture is commercially important in several other regions than those outlined. Thus, in the valley of the Hudson River, grapes have been grown commercially for nearly a hundred

years, the industry reaching its height between 1880 and 1890, when there were 13,000 acres under cultivation. For some years, however, grape-growing along the Hudson has been on the decline. Another region in which viticulture reaches considerable magnitude is in several islands in Lake Erie near Sandusky, Ohio, the product going largely for the manufacture of wine. At one time grapes were grown commercially on the banks of the Ohio River about Cincinnati and westward into Indiana. The industry here, however, is a thing of the past. Another region in which grape-growing was once of prime importance but now lags has its center at Hermann, Missouri. The newest grape-producing area worthy of note is in southwestern Michigan about the towns of Lawton and Paw Paw. A small but very prosperous grape-growing region has its center at Egg Harbor, New Jersey. Ives is the mainstay among varieties in this region. In the southern states, Muscadine grapes are grown in a small way in every part of the cotton-belt and varieties of other native species are to be found in home vineyards in the upland regions, but nowhere in the South can it be said that grape-growing is a commercial industry.

The Determinants of Grape Regions

Climate, soil, site, the surface features of the land, insects, fungi and commercial geography are the chief factors that determine regions for money-making in grape-growing. This has been made plain in the foregoing discussion of grape regions, but the several factors must be taken up in greater detail. To bound the regions is of less importance than to understand why they exist — less needful to remember, more needful to understand. From what has been said, the reader has no doubt already concluded that successful grape-growing is in largest measure due to kindliness in climate.

Climate

Under the assumption, then, that climate, of all factors, is chief in playing providence to the grape, let us examine somewhat critically the relations of climate to grape-growing. When analyzed, the essentials of climate, as it governs grape-growing, are found to be six: first, length of season; second, seasonal sum of heat; third, amount of humidity in summer weather; fourth, dates of spring and autumn frosts; fifth, winter temperature; sixth, air currents.

Length of season.

To reach true perfection, each grape variety has a length of season of its own. With each, if it is grown in too low a latitude, the vine is uninterrupted in growth; its leaves tend to become evergreen; and not infrequently it produces at the same time blossoms, green fruits and ripe fruits. This is, of course, the extreme to which grapes pass in the far South. Again, many northern varieties fail where southern grapes succeed because the fruits pass too rapidly from maturity to decay. On the other hand, very often southern grapes are hardy in vine in the North, but the season is not sufficiently long for the fruit to mature and to acquire sufficient sugar to give them good keeping quality, properly to pass through vinous fermentation, or even to make a good unfermented grape-juice. In the uneven topography of this continent, it is not possible to state the range in latitude in which grapes can be cultivated to advantage, for latitude is often set aside by altitude. Thus, isothermal lines, or lines of equal temperature, are much curved in America and do not at all coincide with the parallels of latitude.

Other factors, of course, than length of season enter into the ripening of grapes. The daily range in temperature, not always dependent on latitude, affects ripening. Cool nights may

offset warm days and delay ripening. Certainly rains, fogs and humid air delay maturity. The bottom heat of loose, warm, dry gravelly or stony soils hastens maturity. Sunshine secured by a sunny aspect or shelter hastens maturity.

The seasonal sum of heat.

Successful cultivation of the grape depends on a sufficient amount of heat during the summer season. The theory is that buds of the grape commence to start when the mean daily temperature reaches a certain height, and that the sum of the mean daily temperature must reach a certain amount before grapes ripen. Manifestly, this sum must vary much with different varieties, low for the earliest sorts, high for the latest. There have been many observations as to the temperatures at which buds of the grape start growth, so that it is now known that the temperature varies in accordance with locality and degree of maturity. Roughly speaking, grape buds start at temperatures from 50° to 60° F. The seasonal sum of heat for ripening is probably 1600 to 2400 units. A variety ought not to be planted, therefore, in a region in which the average seasonal sum of heat is not sufficiently high. The seasonal sum of heat can be determined for a locality from data published by the United States Weather Bureau; and by comparing with the sum of heat units in localities where a variety is known to thrive, the grape-grower can determine whether there is sufficient heat for any particular variety.

The grape seldom suffers from hot weather in a grape region. The fruit is sometimes scalded in the full blaze of a hot sun, but the ample foliage of the vine usually furnishes protection against a burning sun. At maturing time, the heat of an unclouded sun, if the air circulates freely, insures a finely finished product. Deep planting helps to offset the harmful influences of warm climates.

Humidity of summer weather.

The grape is very sensitive to moisture conditions, and grows best in regions where the summer rainfall is comparatively light. A damp and cloudy summer brings disaster to the vineyard in several ways; as small growth of vine, small set of fruit, a crop of poor quality, and the development of the several fungous diseases. Although the grape stands drought, a superfluity of moisture in the soil may do little harm, as is shown in irrigated vineyards, but a humid air is fatal to success especially if the air is both warm and wet. Moist weather during the time of maturity is particularly disastrous to the grape, as are frequent fogs. Cold wet weather in blooming time is the grape-grower's vernal bane, since it most effectually prevents the setting of fruit. It may be laid down as a rule that the grape lives by sunlight, warmth and air — it often thrives on the desert's edge. These considerations make it manifest that the monthly and seasonal means of precipitation must be considered in selecting a locality to grow grapes.

Spring and autumn frosts.

The average date at which the last killing frost occurs in the spring often determines the limit in latitude at which the grape can be grown. Even in the most favored grape region of the continent, killing frosts occasionally destroy the grape crop, and there are few seasons in which frost does not take some toll. Thus on May 7, 1916, frost all but ruined the crop of wine- and table-grapes in the great grape region of northern California where frosts are seldom expected in May. Little or nothing can be done to protect grapes from frost. Windbreaks as often favor the frost as the vine, and smudging or heating the vineyards is too expensive to be practical. In growing grapes, therefore, the commonly recognized precaution of

selecting a site near water, on slopes or in a warm thermal belt must be exercised.

The limits of grape culture are also determined by early autumn frosts. The grape stands two or three degrees of frost, but anything lower usually destroys the crop. Here, again, the only precaution is to take pains in selecting the site.

The use of weather data and dates of life events of the grape.

These considerations of length of season, humidity and spring and fall frosts make it plain that the grape-grower must synchronize these phases of climate with the life events of the grape. In particular, he must study weather data in relation to the blooming and ripening of grapes. Usually, the necessary weather data may be secured from the nearest local weather bureau, while the date of blooming and ripening may be obtained from the state experiment stations in the states where the grape is an important crop.

Winter temperature.

Varieties of native grapes are seldom injured in America by winter-killing, since they are usually planted in climates in which wild grapes withstand winter conditions. Native varieties follow the rule that plant and climate are truly congenial in regions in which the plant thrives without the aid of man. A few varieties of native grapes fare badly in the winter's cold of northern grape regions, and the tender Vinifera vine is at the mercy of the winter wherever the mercury goes below zero. In cold climates, therefore, care must be exercised in selecting hardy varieties and in following careful cultural methods with the tender sorts. If other climatic conditions are favorable, however, winter-killing is not an unsurmountable difficulty, since the grape is easily protected from cold, so easily that the tender Viniferas may be grown in the cold North with winter protection.

Air currents.

Currents of air are of but local importance in growing tree-fruits, but are of general and vital importance in growing the grape. The direction, force and frequency of prevailing winds are often controlling factors in the suppression of fungous diseases of the grape, and the presence of fungi often means success or failure in regions in which the grape is planted. Winds are beneficial, too, when they bring warm air or dry air, and when they keep frosty air in motion. The air must move in all grape regions, whether from cañon, mountain, lake or sea. Sunlight, warmth, and air in motion are life to the grape. Sometimes winds may be detrimental; as when too cold, too blustering, or when they bring hail, the latter being about the most disastrous of all natural calamities. Windbreaks are of small value and are often worse than useless. Having planted his vineyard, the grape-grower must take the winds as they blow.

Soils for grapes

A prime requisite for a vineyard being earth in which vines will grow, successful grape-growing is eminently dependent on the selection of soil. Many mistakes are made in the great grape regions in planting on unsuitable soils, the planter going on the assumption that any soil in a grape region should be good enough for the grape. But the crust of the earth in grape regions is not all grape soil. In New York, for example, much of the land in the three grape regions is better fitted for producing crops for the mason or road-mender than for the grape-grower. Other soils in these regions are fit for vineyards only when tiled, and tiling does not make all wet land fit for tilling. Heavy, clammy clays, light sands, soils parched with thirst, thin or hungry soils — on all of these the grower may plant but will seldom harvest.

The ideal soil.

Grapes may be well grown in a wide range of soils if the land is well drained, open to air and if it holds heat. But without these essentials, whatever the soil, all subsequent treatment fails to produce a good vineyard. Generally speaking, the grape grows best in a light, free-working, gravelly loam, but there are many good vineyards in gravelly or stony clays, gravel or stone to furnish drainage, let in the air and to hold heat. Contrary to general belief, the grape seldom thrives in very sandy soils unless there is a fair admixture of clay, considerable decomposing vegetable matter and a clay subsoil. The latter, however, must not come too close to the surface. Some of the best vineyard lands in the country are very stony, the stones hindering only in making the land difficult to till. Nearly all grapes require a friable soil, compactness being a serious defect. Virgil, writing in Christ's time, gave good advice as to soil for the vine:

> "A free loose earth is what the vines demand,
> Where wind and frost have help'd the lab'rer's hand,
> And sturdy peasants deep have stirr'd the land."

Cold, churlish, sticky or clammy clays are never to the liking of the grape.

Great fertility is not necessary in grape lands. Indeed, the grape is conspicuous among cultivated plants for ability to nourish itself where the food supply is scant. Soils naturally too rich produce an overgrowth of vine, the season's wood does not mature, the crop does not set, and the grapes lack sugar, size, color and flavor. Good physical condition and warmth in a well-watered, well-aired soil enable the grape to search far and wide for its food.

Drainage.

No cultivated grape endures a wet soil; all demand drainage. A few sorts may thrive for a time in moist, heavy land, but more

often they do not live though they may linger. The water-table should be at least two feet from the surface. If by chance this comes naturally, so much the better, but otherwise the land must be tile-drained. Sloping land is by no means always well drained, many hillsides having a subsoil so impervious or so retentive of moisture that under-drainage is a necessity. The texture of the land is usually improved so greatly by good drainage that the grower has little need to rely on the clemency of the season in carrying on vineyard cultivation in well-drained land.

Soil adaptations.

In the refinement of viticulture, grape-growers find that particular varieties grow best in a particular soil, the likes and dislikes being determined only by trial, for the peculiarities which adapt a soil to a variety are not analyzable. Some varieties, on the other hand, the Concord being a good example, grow fruitfully in a great variety of soils. Each of the several species with their varieties has quite distinct adaptations to soils. This is taken advantage of in planting varieties on uncongenial soils after they have been grafted on a vine which finds itself at home in the particular soil. Much has been accomplished in growing varieties on uncongenial soils by consorting them with other stocks, an operation which has brought forth volumes of discussion as to the adaptabilities of cions to stocks and stocks to soils, subjects to receive attention on a later page.

Insects and fungi

The profitable grape regions of the country have all been established in regions comparatively free from grape insects and fungi. If pests came later in considerable numbers, the industry, in the old days, perished. Here and there in the agricultural regions of the country may be found a sorry company of

halt and maimed vines, remnants of once flourishing vineyards, brought to their miserable condition by some scourge of insects or fungi. The advent of spraying and of better knowledge of the habits of the pests has greatly lessened the importance of parasites as a factor in determining the value of a region for grape-growing; but even in the light of the new knowledge, it is not wise to go against Nature in regions where pests are strongly intrenched.

Commercial factors

The dominant factors that lead to the planting of large areas to any one fruit are often economic ones; as transportation, markets, labor, facilities for making by-products, and opportunity to join in buying and selling organizations. All of these factors play an important part in determining the bounds of grape regions, but a lesser part than in the establishment of large areas of other fruits, for the reason that the grape is so largely grown for raisins, wine, champagne and grape-juice, products condensed in form, made with little labor, easily transported, which keep long and find ready market at any time. Again, where natural conditions are favorable for grape-growing, the crop comes almost as a gift from Nature; whereas, if the grower must breast the blows of unfavorable natural circumstances, no matter how favorable the economic factors may be, the vineyard is seldom profitable. Natural factors, therefore, outweigh economic ones in grape-growing, but the latter must be considered in seeking a site for a vineyard, a task discussed under several heads to follow.

Accessibility to markets.

Markets ought to be accessible in commercial grape-growing. A location in which there is a good local market, and at the same time ample facilities for shipping to distant markets, is

desirable. If there are also opportunities to dispose of any surplus to makers of raisins, wine or grape-juice, the grower has well-nigh attained the ideal. Further to be desired are good roads, short hauls, quick transportation, reasonable freight rates, refrigerator service and coöperative agencies. The more of these advantages a grower has at his disposal, the less likely he is to fail in commercial competition.

General versus *local markets.*

The grower must be reminded rather than informed that he must decide in locating his vineyard whether he will grow for distant markets, for manufacturing into grape products, or for local markets. Determination to grow grapes once made, subsequent procedure at every step depends on the disposition to be made of the product. Summarized, the differences in growing grapes for the two markets are: For the general market: the acreage should be large; the market may be distant; the varieties few; the cost of production low; sales large and prices low; the dealings are with middlemen; and extensive culture is practiced. For the local market: the acreage may be small; the market must be near and prices must be high; the sales are direct to the consumer; there must be succession in ripening; and intensive culture is practiced. For the general market, the vineyard is the unit; for the local market, the variety should be the unit. In this discussion, however, "large acreage" and "extensive culture" set against "small acreage" and "intensive culture" may mislead. This is a case in which a large endeavor may be a small endeavor, and a small endeavor a large one; or, in which it may be well to take the advice of Virgil, who advised Roman vineyardists, "Praise great estates; farm a small one."

The grape-growing of the times tends more and more to growing for general markets. The grower plants to skim a comparatively small return from a large area. This division

of grape-growing is now well developed in America. Intensive grape-growing for local markets is not well developed. There are, however, many opportunities in America for easy triumphs in fruit-growing in the planting of vineyards for local markets. No other fruit responds to fine art in culture so well as the grape. Given choicely good varieties and a finely finished product, and the grower may have almost what he desires for the produce of his skill. With the grape, too, palm of merit goes with skill in culture; among all who grow plants, only the florist can rival the viticulturist in guiding the development of a plant to a special end. In cultivating, fertilizing, training, grafting, pruning, spraying, in every cultural operation, the grape-grower has opportunities to sell his skill not given in so high degree to the grower of other fruits.

Labor.

A great advantage in the congregation of vineyardists in grape regions is found when labor must be obtained. Skilled labor is required to cultivate the vine, and such labor can be freely secured only in centers of viticulture. Grape-growing is a specialists' business, and it takes more than a day or a season to make a vine-dresser out of a farmer, gardener or an orchardist. Expert labor is most easily obtained and is of best quality where grapes abound. Common labor must be somewhat abundant, also, in good vineyard locations, for such rush tasks as tying and picking. In these two operations, women, children or other unskilled labor may be employed to advantage. The grape harvest must often be hurried, and to keep it in full swing a near-by city from which to draw pickers is a great asset.

Vineyard sites.

Within a grape region, the site is important in determining where to plant. The site is the local position of the vineyard.

Sites cannot be standardized, and therefore no two are alike. The cardinal natural factors to be secured in a site are warmth, sun, air and freedom from frost. These factors have been discussed in a general way under the climate of grape regions, but one needs to particularize a little more closely to ascertain how they affect individual vineyards. Warmth, sun, air and frostlessness are best secured by proximity to water, high land and proper exposure.

Proximity to water.

The favorable influences of water are well illustrated in the grape regions of New York, Pennsylvania, Ohio and Canada. All of the grape districts in these regions are bounded on one or more sides by water. The equalizing effects of large bodies of water on temperature, warmer winter and cooler summer, are so well known as scarcely to need comment. Hardly less important than the effects of water on temperature are the off-shore breezes of night and the in-shore breezes of day which blow on large bodies of water. These keep the air of the vineyard in constant motion and so prevent frosts in spring and autumn, and also dry foliage and fruit so that spores of fungi have difficulty in finding foothold. But if water brings fogs, dews and humidity, as does the Pacific, grapes must be planted inland; otherwise leaf, bloom and fruit are born in the blight of fungi. The benign influences of water are felt in the eastern grape regions at distances of one to four miles, seldom farther. These narrow belts about the eastern waters are bounded on the landward side by high bluffs over which many showers fail to pass and which protect the belts below from heavy dews. Where the background of bluffs in these regions sinks to level land, vineyards cease.

Vineyards are usually some distance above the water, the range in altitude running from fifty to five hundred feet. Where the altitude is much higher, immunity to frosts and winter

freezing ceases, for the reason that the atmosphere is rarer and drier so that heat radiates rapidly from the land. As the height increases, also, the revels of the wind play havoc with the vines. Yet, one is often surprised to find good vineyards at the level of the lakes or, on the other hand, crowning high hills. Altitude in grape-growing must, therefore, be determined by experiment. We know very little of the formation of the thermal belts on high land so favorable to the grape.

The lay of the land.

We associate the grape with rugged land; as the vines on the banks of the Rhine, the rolling lands of Burgundy, the slopes of Vesuvius and Olympus, the high hills of Madeira, the cloud-capped mountains of Teneriffe, mountain slopes in California and the escarpments of grape regions in eastern America. These examples prove how well adapted rolling lands, inclined plains and even steep and rocky hillsides are to the culture of the vine. Virgil long ago wrote, "Bacchus is partial to broad, sunny hills." Yet rolling lands are not essential to the culture of the grape, for in Europe and America very good grapes are grown on unsheltered plains, provided the land has an elevation on one or more boundaries above the surrounding country. If the conditions of soil and climate which the grape requires can be found on level land or moderate slopes, such situations are much better than steep declivities, since on these the cost of all vineyard operations is greater and heavy rains erode the soil. The soil on hills, too, is often scant and niggardly. Level land, however, must not be shut in on all sides by higher land as untimely frost will often lay waste vines in such a situation.

Exposures.

The exposure, or the slope of the land toward a point of the compass, is important in choosing a site for the vineyard, al-

PLATE II. — Fitting the land for planting.

though the value of particular exposures is often exaggerated. Let it be remembered that good grapes may be grown in vineyards exposed to any point of the compass, but that slight advantages may sometimes come, depending on the particular environment of the plantation, and then solve the problem according to conditions. The following are theories as to exposure: A southern exposure is warmer and hence earlier than a northern, and is, therefore, the best slope for early grapes as well as for very late ones liable to be caught by frost. Northward and westward slopes retard the leafing and blooming period, thus often enabling the grape to escape untimely spring frosts; though to plant on such slopes may be robbing Peter to pay Paul, as what is gained in retardation in spring may be lost in the fall with the result that the vines may be caught by frost and may fail to ripen their crop. Frost damage is usually greatest on a bold eastern slope, and vines suffer most in winter freezes on this exposure, since the direct rays of the rising sun strike the frozen plants so that they are more injured than otherwise by rapid thawing. In locations near bodies of water, the best slope is toward the water, regardless of direction. The exposure may sometimes be selected to advantage with reference to the prevailing winds.

CHAPTER III

PROPAGATION

THE grape commends itself to commercial and amateur growers alike by its ease of propagation. The vines of all species may be propagated from seed, and all but one of the several cultivated species may be grown readily from cuttings or layers. All yield to grafting of one kind or another. Seeds are planted only to produce new varieties. At one time stocks were grown from seed, but this practice has fallen into disrepute because of the great variations in the seedlings. Varieties on their own roots and stocks are for most part propagated from cuttings. In the production of stocks, the viticulturist sets the orchardist a good example, for there can be no question that all tree-fruits suffer from being grown on seedling stocks. The grape is a vigorous, self-assertive plant and once it is started, whether from seeds, cuttings or layers, seldom fails to grow.

SEEDLINGS

Growing seedling grapes is the simplest of operations. The seeds are taken from the grapes at harvest time, after which they must pass through a resting period of a few months. At once or in a month or two, the seeds should be stratified in moist sand and stored in a cold place until spring, when they may be sown in flats or in the open ground; or seed may be sown in a well-prepared piece of garden land in the autumn. When planted in the open, autumn or spring, the seeds are put in at the depth of an inch, an inch or two apart and in rows convenient for cultivation. Subsequent care consists of cultivation

if the seed are sown in garden rows, and in pricking out when true leaves appear if planted in flats. In ground that crusts, an expedient is to mix grape seed with apple seed; the apple seedlings, being more vigorous, break the crust and act as nurse plants to the more tender grapes. Sometimes it is helpful to the young plants to mulch the ground lightly with lawn clippings or moss. Grape seedlings grow rapidly, often making from two to three feet of wood in a season.

The young plants are thinned or set to stand four or five inches apart in the nursery row. At the end of the first season, all plants are cut back severely and almost entirely covered with earth by plowing up to the row on both sides. This earth, of course, is leveled the following spring. If the seasons are propitious and all goes well, the seedlings are ready for the vineyard at the end of the second season, but if for any reason they have fared badly during their first two years, it is much better to give them a third season in the nursery. Seedling vines are seldom as vigorous as those from cuttings, and unusual care must be taken in setting in the vineyard, though the operation is essentially the same as that to be described for vines from cuttings. The third season the vines are kept to a single shoot and are pinched back when the canes reach a length of five or six feet. In the autumn, they are pruned back to two or three feet. In the spring of the fourth season, the trellis is put up and a few fruits may be allowed to ripen.

The vines of promise may now be selected. The plants, however, must fruit twice or oftener before it can be told whether hopes are consummated or must be deferred. Growing seedlings for new varieties is a game full of chances in which, while there may be little immediate or individual gain, there is much pleasure. It is hardly too much to say that the grape industry of eastern America, with its 300,000 acres and 1500 varieties, betokens the good that has come from growing seedling grapes.

Dormant Cuttings

Vines for vineyards, with the exception of varieties of Rotundifolia, are propagated from cuttings of hard wood taken from the season's canes when the vines are pruned. The inactive buds in these cuttings may be brought into active growth, and roots induced to grow from the cut surfaces by various means. By this miracle of Nature, an infinite number of plants, in an endless procession, may be propagated from the product of a single seed, each plant complete in its heredity and differing from its fellows only in accordance with environment.

Time to make cuttings.

A good cutting should have a protective callus over the cut and this requires time, so that the sooner cuttings are made after the wood becomes thoroughly dormant the better. Besides, the cutting should use its stored food material for the formation of adventitious roots rather than have it pass into buds, as it quickly does late in the dormant season when buds are about to open. If cuttings must be made late in the season, transplanting must be delayed as long as possible, and the cuttings be set in a northerly aspect to prevent the premature development of the buds. However, the grape responds surprisingly well to the call of Nature in forming roots, and great importance need not be attached to the time at which the cuttings are made.

Selecting cutting wood.

Cuttings are made from one-year-old wood; that is, canes produced during the summer are taken for cuttings in the fall. Immature canes and those with soft, spongy wood ought not to be used. Strong vigorous canes should be given preference over weak growth, but most nurserymen maintain that very large canes do not make as good cuttings as do those of medium

size, the objection to large size being that the cuttings do not root as well. Short-jointed wood is better than long-jointed. Cuttings from vines weakened by insects and fungi are liable to be weak, soft, immature and poorly stored with food. The wood should be smooth and straight.

Making the cutting.

Grape cuttings vary in length from four inches to two feet, the length depending on the climate and the soil of the nursery and the species and variety. The hotter and drier the climate and the lighter the soil, the longer the cutting needs to be. Six to nine inches, however, is the usual length in the climate of eastern America, while on the Pacific slope the length varies from eight to fifteen inches. For convenience in handling, all cuttings should be approximately of the same length, to insure which some kind of simple gauge is needed. Various gauges are used, as marks cut in the working table, a stick of the required length, or a cutting-box.

In making the cuttings, a slanting cut is made close below the lowest bud, while about an inch of wood is left above the upper bud. When possible, a heel of old wood is left at the lower end; or, still better, a whorl of buds, as roots usually start from each bud. The finished cuttings are tied in bundles, all butts one way, and are then ready to be heeled-in. This is done by burying in trenches, butts up, and covering with a few inches of soil. It is important to invert the cuttings in trenching, since otherwise the tops often start to grow before the butts are properly calloused, and it is very essential that the tops remain dormant until roots appear to support the new growth.

Planting the cuttings.

Cuttings are planted in the nursery in rows wide enough apart for cultivation and two or three inches apart in the row. Trenches are made with a plow; perpendicular if the cuttings

are shorter, and a little slanting if longer than six inches. The cuttings are set at a depth which permits the upper buds to project above the ground, as shown in Fig. 6. When the cuttings in a row are placed, two inches of soil are put in and pressed firmly about the base of the cuttings. Then the trench is evenly filled with earth and the cultivator follows. Doing duty by the young plants consists in cultivating often during the summer to keep the soil moist and mellow.

FIG. 6. Planting cuttings.

The cuttings are planted as soon as the ground is warm and dry enough to work. To delay planting too long invites injury from drought, which almost annually parches the land in eastern America. Irrigation gives more leeway to planting time in the West. When warm sunny weather, accompanied by an occasional shower, predominates, the cuttings start growth almost at once, as shown in Fig. 7, and by fall, all things being propitious, make a growth from four to six feet. With the cuttings three inches and the rows three feet apart, 58,080 vines may be grown to the acre.

FIG. 7. A cutting beginning growth.

Single-eye cuttings.

New and rare varieties are propagated from single-eye cuttings, thereby doubling the number of plants from the propa-

gating wood. This method gives an opportunity, also, to start the work of propagating early in the season, since single-eye cuttings are nearly always rooted by artificial heat. But the greatest value of the method is that some varieties which cannot be propagated in any other way readily grow under artificial heat from single-eyes. Well-grown vines so propagated are as good as those grown by any other method, but the great disadvantage is that unless much care and skill are used, vines from these cuttings are poor and quite worthless. It is also a more expensive method than growing from long cuttings out of doors.

There are several ways of making single-eye cuttings. The most common form of the cutting is the single bud with an inch of wood above and below, the ends being cut with a slant. Some modify this form by cutting away the wood on the side opposite the bud, exposing the pith the whole length of the cutting. In another form, a square cut is made directly under the bud, leaving an inch and a half of wood above. Or this last form is modified by making a long sloping cut from the bud to the upper end, thereby exposing the maximum amount of cambium. Advantages are claimed for each form, but these are mostly imaginary, and the cutting may be made to suit the fancy of the propagator if a few essentials are observed.

Single-eye cuttings are made in the fall and are stored in sand until late winter, about February in New York. At this time the cuttings are planted horizontally an inch deep in a sand propagating bench in a cool greenhouse. If the cuttings are not well calloused, they remain one or two weeks in a temperature of 40° to 50° without bottom heat, but well-made cuttings are calloused and ready to strike root so that brisk bottom heat can be applied at once. After six weeks or two months, the young plants are ready to pot off or to transplant in a cold-frame or cool greenhouse. If but a few plants are to be grown, they may be started in two- or three-inch pots, shifting into

larger pots once or twice as growth progresses. In early summer, the young plants are set in nursery rows out of doors and by fall the young vines should be strong and vigorous.

Single-eyes are also started in hot-beds, cold-frames and even in the open air without the aid of artificial heat. In hot-beds and cold-frames, the method is only a modification of that described for greenhouses. Out of doors the cuttings are given the same conditions under which long cuttings are rooted, except that the whole of the short cutting is buried an inch deep in the nursery row.

Herbaceous Cuttings

Grapes are easily propagated from herbaceous cuttings, although since the vines are weak and the method expensive, they are seldom used. Green cuttings are usually taken from plants forced in greenhouses, but may be taken in summer from vineyard vines. A green cutting is usually cut with two buds with the leaf at the upper one left on. The cuttings are set in propagating beds of sand, or pots of sand, in close frames under which there is brisk bottom heat. To prevent excessive evaporation, the frames are kept closed and the atmosphere warm and moist. As growth progresses, or if mildew appears, the frames are more and more ventilated. In two to four weeks, the cuttings should have rooted sufficiently well to be transplanted to pots. Herbaceous cuttings made in the summer must be kept under glass until the following spring.

Layering

The grape is readily propagated from layers of either green or mature wood, the method being certain, convenient and producing extra vigorous plants. The drawback is that fewer plants can be obtained by layering than from cuttings with a

given amount of wood. Varieties of some species, however, cannot be propagated by cuttings, and with these layering becomes of supreme importance to the propagator. Nearly all varieties of Rotundifolia and some of Æstivalis are best grown from layers. So far as is known, all varieties of cultivated species may be grown by layering, and since the method is simple and certain and the vines vigorous and easily handled, this method is commended to small growers of grapes.

Dormant wood layering.

The work of layering mature wood usually begins in the spring, but the vines from which the layers are to be taken should have received preliminary treatment the preceding season. The vines to be layered are severely cut back a year or more before the layering is to be done to induce a vigorous growth of canes. Strong vigorous canes are laid in a shallow trench, two to five inches deep, in which they are fastened with wood or wire pegs or staples. The trench is then partly filled with fine, moist, mellow earth which is firmly packed about the cane. Roots strike and shoots spring from each joint. When the young plants are well above ground, the trench is completely filled, and then, or a little later, the young plants are staked to keep them out of the way of the cultivator. The following fall the young vines are ready to transplant.

The essentials of layering have been given, but a number of non-essentials may be helpful under some conditions. Thus, dormant wood may be layered in the fall, in which case the cane is usually notched or ringed at the joint to induce the formation of roots. The less the number of joints covered, the stronger the young vines, so that while the number is usually five, six or more extra vigorous plants may be obtained by covering only one or two joints. In propagating Rotundifolia grapes, it is expected that lateral branches will make the tops of the new plants. These, at the time of layering, are

cut back to eight or ten inches, all on the same side of the vine, and are not left closer together than twelve inches. In nursery practice, Rotundifolia vines are trained along the ground for layering. Vines on arbors, in greenhouses, or on sides of buildings are easily layered in boxes or pots of soil. Plants grown from layers are not as conveniently handled as those from cuttings.

Green wood layering.

Layered plants from green wood are sometimes grown to multiply quickly new or rare varieties. The work is accomplished in midsummer by bending down and covering shoots of the present season's growth. Strong plants are seldom obtained from summer-layering and it is never safe to attempt to grow more than one or two plants from a shoot. The most forceful culture possible must be given summer-layered plants after the separation from the parent vine. It is very generally agreed that plants from summer-layers not only do not give good plants, but that the parent vine is injured in taking an offspring from it in this way.

Layering to fill vacancies in the vineyard.

There is sure to be an occasional gap even in the best vineyard. Young plants set in vacancies must compete with neighboring full-grown vines, and often in a bit of land so unfavorable that it may have been the cause of the demise of the original occupant. Under these circumstances, the newcomer stands a poor chance for life. A plant introduced by layering a strong cane from a nearby vine has little difficulty in establishing itself on its own roots, after which it can be separated from the parent. Such layering is best done by taking in early spring a strong, unpruned cane from an adjoining plant in the same row and covering an end joint six inches deep in the vacant place, but leaving sufficient wood on

the end of the cane to turn up perpendicularly out of the soil. This free end becomes the new plant and by the following fall or spring may be separated from its parent. Not infrequently the young plant bears fruit the second season on its own roots. This method is of especial value in small plantations, whereby the trouble of ordering one or two plants is avoided and the advantage of early fruiting is obtained.

Grafting

Since grafting grapes is intimately connected with stocks, the growing of which is a modern practice, grafting is thought of as a new process in growing this fruit. Quite to the contrary, it is an old practice. Cato, the sturdy old Roman grape-grower who lived nearly two hundred years before Christ, speaks of grafting grapes, although Theophrastus, the Greek philosopher, wrote a hundred years before "the vine cannot be grafted upon itself." However, until it became necessary to grow Vinifera grapes on resistant stocks to avoid the ravages of phylloxera, grafting the grape was not at all common among vineyardists and is not now except where vines susceptible to phylloxera must be grown in consort with roots resistant to this insect, or to modify the vigor of the top by a stock more vigorous or less vigorous. For these two purposes, grafting is now in some grape regions one of the most important vineyard operations.

In grafting the grape, there is a time and a way, not so particular as many believe, but rather more particular than in grafting most other fruits. If the essentials of grafting are kept in mind, one has considerable choice of details. Grafting consists in detaching and inserting one or several buds of a mother plant on another plant of the same or a similar kind; the bud stock is the cion, the rooted plant is the stock. The essentials may be set forth in three statements: First, the prime essential is that the cambium layers, the healing tissue

lying between the bark and wood, meet in the cion and stock; second, that method of grafting is best in which the cut tissues heal most rapidly and most completely; third, the greater the amount of cambium contact, as compared with the whole cut surface, the more rapidly and completely the wounds will heal. Out of a great many, the following are a few of the simplest methods in use in grafting the grape, any one of which may be modified more or less as occasion calls.

Vineyard grafting in eastern America.

In eastern America, the growing vine is usually grafted. At the New York Agricultural Experiment Station, the operation is very successfully performed on old vines as follows: Preparatory to grafting, the earth is removed from around the stock to a depth of two or three inches. The vines are then decapitated at the surface of the ground and at right angles with the axis of the stock. If the grain is straight, the cleft can be made by splitting with a chisel, but more often it will have to be done with a thin-bladed saw through the center of the stock for at least two inches. The cion is cut with two buds, the wedge being started at the lower bud. The cleft in the stock is then opened, and the cion inserted so that the cambium of stock and cion are in intimate contact. If the stock is large, two cions are used. The several operations in grafting are shown in Figs. 8, 9, 10 and 11. Grafting wax is unnecessary, in fact is often worse than useless, and if the stock is large the graft is not even tied. Raffia is used to tie the graft in young vines. It suffices to mound the graft to the top of the cion with earth, for the purposes of protec-

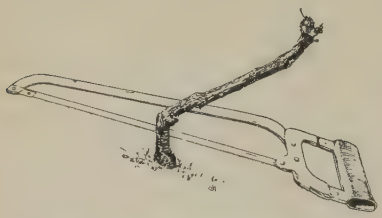

FIG. 8. Cutting off the trunk.

tion and to keep the graft moist. Two or three times during the summer, sprouts coming from the stock or roots from the cion should be removed.

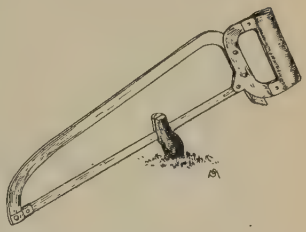

Fig. 9. Cutting the cleft.

A method used with fair success at the New York Agricultural Experiment Station with young vines is to plant one-year-old stocks in the nursery row as soon as the ground can be worked in the spring. Just as the vines start in growth, these are cut off at the surface of the ground and whip- or cleft-grafted with a two-eye cion. The graft is tied with raffia, after which it is all but covered with a mound of soil. This is a case in which the work must be done at the accepted time, as it is fatal to delay.

Fig. 10. Inserting the cion.

R. D. Anthony describes another method as follows:[1] "A method which a Pennsylvania grower of Viniferas has found very satisfactory is to root the Vinifera cuttings, and grow them one year on their own roots; then the vine which is to be used as a stock is planted in the vineyard and the rooted cutting planted beside it so that the shoots from the two may be brought in contact with each other. In June when the plants are in full growth, two vigorous shoots (one from each vine) are brought together and a cut two or three inches long made in each parallel to the length of the cane removing from one-third to one-half of the thickness of the shoot. These flat surfaces

Fig. 11. The completed graft.

[1] Anthony, R. D. *N. Y. Agr. Exp. Sta., Bul. 632:* 88. 1917.

exposed by the cuts are then brought into contact with the cambium tissues touching and are tied in place. The tops are checked somewhat by breaking off some of the growth. The following spring the Vinifera roots are cut off below the graft and the top of the stock above the graft is removed."

In the subsequent care of these young vines, the grower must take time by the forelock and tie the grafts to suitable stakes; otherwise they are liable to be broken off at the union by wind or careless workmen. Grafted vineyards must have extra good care in all cultural operations, and even with the best of care from 5 to 50 per cent of the grafts will fail or grow so poorly as to make regrafting necessary, this being the most unfavorable circumstance of field grafting. Regrafting is done one joint lower than the first operation to avoid dead wood; this brings the union below the surface of the ground, and the vineyardist must expect many cion roots to try his patience.

Vineyard grafting on the Pacific slope.

Vineyard grafting, according to Bioletti,[1] was formerly the commonest method of starting resistant vineyards in California. After stating that it is best whenever possible to plant good cuttings rather than roots, and that the grafting should usually be done the year after planting, Bioletti gives the following directions for grafting:[2]

"Wherever possible the vines should be grafted at or above the surface of the ground. In many cases, however, it will be necessary to go below the surface to find a smooth, suitable part of the stock where grafting is possible.

"The kind of graft to use will depend on the size of the stock. For stocks up to $\frac{2}{3}$ inch in diameter the methods of tongue and wire grafting already described are the best. For larger vines

[1] Bioletti, Frederic T. *Calif. Exp. Sta., Bul. 180:* 135. 1906.
[2] *Ibid.*, 136–138.

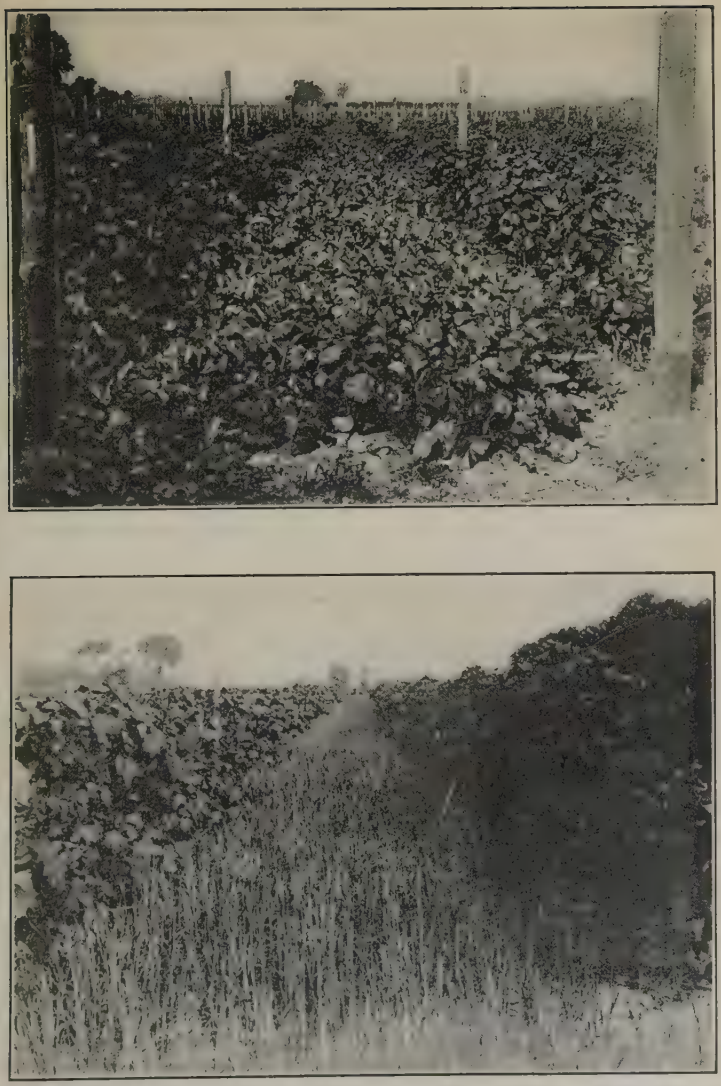

PLATE III. — Cover-crops. *Top*, cow-horn turnips; *bottom*, rye.

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up to ¾ inch a modification of the ordinary tongue graft is the best. If the tongue graft were made in the usual way with stocks of this size, it would be necessary to use excessively large scions, which is undesirable, or to have the barks unite only on one side. By cutting the bevel of the stock only part way through the vines, it is possible to make a smaller scion unite on both sides. For still larger vines, those over ¾ inch in diameter, the best graft is the ordinary cleft.

"No wax or clay should be used on the graft. Anything which completely excludes the air prevents the knitting of the tissues. A little clay, cloth, or a leaf may be placed over the split in the stock when the cleft graft is used, simply to keep out the soil. Otherwise there is nothing more suitable or more favorable to the formation of a good union that can be put around the graft than loose, moist soil. If the soil is clayey, stiff or lumpy, it is necessary to surround the union with loose soil or sand brought from outside the vineyard.

"It will usually be necessary to tie the grafts. A well-made cleft graft often holds the scion with sufficient force to prevent its displacement and no tying is necessary. Wherever there is any danger of the graft moving, however, it should be tied. There is nothing better for this purpose than ordinary raffia. The raffia should not be bluestoned, as it will last long enough without and will be sure to rot in a few weeks, and the trouble of cutting it will be avoided. Cotton string or anything which will keep the graft in place for a few weeks may also be used.

"As soon as the graft is made and tied, a stake should be driven and the union covered with a little earth. The hilling up of the graft may be left for a few hours, except in very hot, dry weather. Finally, the whole graft should be covered with a broad hill of loose soil 2 inches above the top of the scion.

"Field grafting should not be commenced as a rule, except in the hottest and driest localities, before the middle of March.

Before that there is too much danger that heavy rains may keep the soil soaked for several weeks — a condition very unfavorable to the formation of good unions. In any case the grafting should not be done while the soil is wet. Grafting may continue as long as the cuttings can be kept dormant. It is difficult to graft successfully, however, when the bark of the stock becomes loose, as it does soon after the middle of April in most localities."

As in the East, it is necessary in California to remove suckers from the roots and roots from the cions once or twice during the summer. Suckers should not be allowed to overshade the graft, though it is best not to remove them until danger of disturbing the graft is past. The grafts should be staked and the vines looked after as recommended for eastern conditions.

Bench grafting.

The resistant vineyards of France and California are now started almost entirely with bench-grafted vines. It has been learned in these regions that a grafted vine, to be a permanent success, must have the consorting parts perfectly united, and that the sooner the grafting is done in the life of stock and cion the better the union. Cions of the variety wanted are, therefore, grafted on resistant roots or resistant cuttings in the workshop and then planted in the nursery. Bench grafting has the advantage over field grafting in time gained and in securing a fuller stand of vines.

Bench grafting really begins with the selection of cuttings, since success largely depends on good cuttings of both stock and cion. Cuttings are taken from strong healthy vines and are of medium size, with short to medium joints. The best size is one-third of an inch in diameter, that of stock and cion being the same since the two must match exactly. The cutting-wood may be taken from the mother vines at any time during the dormant season up to two weeks before buds swell in the

spring, and the cuttings can then be made as convenience dictates, though meanwhile the wood must be kept cool and moist, which is best done by covering them with moist but not wet soil or sand in a cellar or cool shed. In California, the best results are obtained when the grafting is done in February or March, though it may be begun earlier and continued a month later.

Preparation of cuttings.

The stocks are cut into lengths of about ten inches, a gauge being used to secure uniform length. The cut at the bottom is made through a bud in such a way as to leave the diaphragm. The top cut is made as near ten inches from the bottom as possible, leaving about one and one-half inches above the top bud for convenience in grafting. The stock is then disbudded, taking both visible and adventitious buds, the latter indicated by woody enlargements, to keep down the number of suckers.

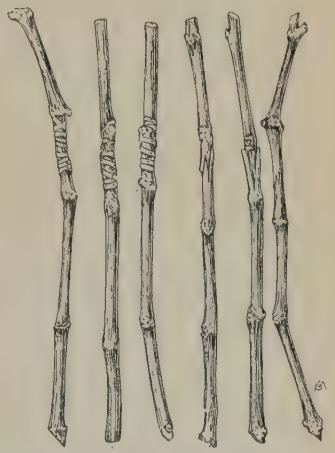


Fig. 12. Bench-grafted cuttings of grape, showing both the cleft-graft and the whip-graft.

The cion should be made with but one bud, thereby gaining the advantage of having every cion the same length so that all unions are at the same distance below the surface of the ground in the nursery. The cion is made with about two and one-half inches of internode below the bud and one-half inch above, a sharp knife being the best tool for making the cuts.

Stock and cion cuttings are now graded to exactly the same diameters, this being necessary to secure perfection in the unions.

Three methods of uniting stock and cion are illustrated in Fig. 12. It suffices to grade by the eye into three lots — large, small and medium — but some nurserymen prefer to secure even greater accuracy by the use of any one of several mechanical gauges. The methods of uniting stock and cion may be described best by quoting Bioletti, from whom most of the details already given have been summarized: [1]

Tongue grafting.

"When the stocks and scions are prepared and graded the grafter takes a box of stocks and a box of the corresponding size of scions and unites them. Each is cut at the same angle in such a way that when placed together the cut surface of one exactly fits and covers the whole of the cut surface of the other. The length of cut surface should be from three to four times the diameter of the cutting, the shorter cut for the larger sizes and the longer for the thinner. This will correspond to an angle of from 14.5 to 19.5 degrees. The cut should be made with a sliding movement of the knife. This will make the cut more easily and more smoothly.

"The cut should be made with a single quick motion of the knife. If the first cut is not satisfactory, a completely new one should be made. There should be no paring of the cut, as this will make an irregular or wavy surface and prevent the cuttings coming together closely in all parts.

"The tongues are made with a slow, sliding motion of the knife. They are commenced slightly above one-third of the distance from the sharp end of the bevel and cut down until the tongue is just a trifle more than one-third the length of the cut surface. The tongue should be *cut*, not *split*. The knife should not follow the grain of the wood, but should be slanted in such a way that the tongue will be about one-half as thick as it would be if made by splitting. Before withdraw-

[1] Bioletti, Frederic T. *Calif. Exp. Sta., Bul. 180:* 108–112.

ing the knife it is bent over in order to open out the tongue. This very much facilitates the placing together of stock and scion.

"The stock and scion are now placed together and, if everything has been done properly, there will be no cut surface visible and the extremity of neither stock nor scion will project over the cut surface of the other. It is much better that the points should not quite reach the bottom of the cut surface than that they should overlap, as the union will be more complete and the scions will be less liable to throw out roots. If the points do overlap, the overlapping portion should be cut off, as in the Champin grafts.

"A skillful grafter, by following the above-described method, will make grafts most of which will hold together very firmly. Many of them would be displaced, however, in subsequent operations, so that it is necessary to tie them. This is done with raffia or waxed string. The only object of the tying is to keep the stock and scion together until they unite by the growth of their own tissues, so that the less material used the better, provided this object is attained. For the formation of healing tissue air is necessary, so that clay, wax, tinfoil or anything that would exclude the air should not be used. The tying material is passed twice around the point of the scion to hold it down firmly, and then with one or two wide spirals it is carried to the point of the stock, which is fastened firmly with two more turns and the end of the string passed under the last turn. The less string is used the more easily it is removed later in the nursery.

"Untreated raffia should be used for late grafts which are to be planted directly out in the nursery, but if the grafts are to be placed first in a callusing bed it is best to bluestone the raffia in order to prevent rotting before the grafts are planted. This is done by steeping the bundles of raffia in a three per cent solution of bluestone for a few hours and then

hanging them up to dry. Before using, the raffia should be washed quickly in a stream of water in order to remove the bluestone which has crystallized on the outside and which might corrode the graft.

"Some grafters prefer waxed string for grafting. The string should be strong enough to hold the graft, but thin enough to be broken by hand. No. 18 knitting cotton is a good size. It is waxed by soaking the balls in melted grafting wax for several hours. The string will absorb the wax, and may then be placed on one side until needed. A good wax for this purpose is made by melting together one part of tallow, two parts of beeswax, and three parts of rosin."

Wire grafting.

"The merits claimed for this method are that it is more rapid, requires less skill, and does away with the troublesome tying and still more troublesome removal of the tying material. Practiced grafters can obtain as large a percentage of No. 1 unions by this method as by any other, and unpracticed grafters can do almost as well as practiced. Another advantage of the method is that the scions have less tendency to make roots than with the tongue graft.

"It consists essentially of the use of a short piece of galvanized iron wire inserted in the pith of stock and scion for the purpose of holding them together, thus replacing both tongues and raffia. It has been objected that the iron would have a deleterious effect on the tissues of the graft, corroding them, or causing them to decay. There seems, however, no reason to expect any such result, and vines grafted in this way have been bearing for years without showing any such effect.

"The preparation and grading of stocks and scions are exactly the same for this method as for the tongue graft.

"Stock and scion are cut at an angle of 45 degrees. A piece of galvanized iron wire two inches long is then pushed one inch

into the firmest pith. This will usually be the pith of the stock, but it will depend on the varieties being grafted. The scion is then pushed on to the wire and pressed down until it is in contact with the stock. If the cuttings have large pith it is better to use two pieces of wire, one placed in the stock first and the other in the scion.

"The length of wire to use will vary with the size and firmness of the cuttings, but 2 inches will usually be found most satisfactory. Wire of No. 17 gauge is the most useful size."

Making bundles.

"If the grafts are to be planted out directly in the nursery, they may be simply laid in boxes or trays, covered with damp sacks, and carried out to be planted as soon as made. It is usually better, however, to place them for several weeks in a callusing bed before planting. In this case it is necessary for convenience of handling to tie them up into bundles. No more than twenty grafts should be placed in a bundle, and ten is better. If the bundles are too large there is danger of the grafts in the middle becoming moldy or dry.

"A stand is very convenient. It consists of a piece of board 12 inches, on one end of which is nailed a cleat 6 inches by 4 inches and under the other end a support of the same size. Two 4-inch wire nails are driven through the board from below, 4 inches apart and 5 inches from the cleat. Two other 4-inch nails are driven similarly at $1\frac{1}{2}$ inches from the other end. The grafts are laid on this stand with the scions resting against the cleat, and are then tied with the two pieces of bluestoned raffia that have previously been placed above each pair of nails. This arrangement insures all the scions, and therefore the unions, being at the same level, and puts both ties below the union where they will not strain the graft. The tying is more expeditious and less liable to disturb the unions than if the bundles are made without a guide.

"A skillful grafter will make about one hundred tongue grafts on cuttings per hour, or from sixty-five to seventy-five per hour if he does the tying as well. Wire grafts can be made at the rate of two hundred and fifty or more per hour, and by proper division of labor where several grafters are employed this number can be easily exceeded. These estimates do not include the preparation and grading of the cuttings."

Grafting rooted cuttings.

The cion may be grafted on a stock rooted in the nursery the previous season, much the same methods being used as with cuttings. This method is employed to utilize cuttings too small to graft, the added sizes attained in the nursery making them large enough, and in grafting on stocks which root with difficulty, thus saving the making of grafts which never grow. The stocks, in this method, are cut so that the cions may be inserted as the original cutting and not as the new growth. The roots, for convenience in handling, are cut back to an inch or thereabouts in length.

The callusing bed.

If bench grafts are planted at once in the nursery, most of them fail. They are, therefore, stratified in a callusing bed where moisture and temperature can be controlled. Bioletti describes a callusing bed and its use as follows:[1]

"This callusing bed is usually a pile of clean sand placed on the south side of a wall or building and surrounded by a board partition where there is no possibility of its becoming too wet by the flow of water from a higher level or from an overhanging roof. It should be protected, if necessary, by a surrounding ditch. It should be furnished with a removable cover of canvas or boards to protect it from rain and to enable the temperature to be controlled by the admission or exclusion

[1] Bioletti, Frederic T. *Calif. Exp. Sta., Bul. 180:* 113–118.

of the sun's rays. A water-proof wagon-cover, black on one side and white on the other, is excellent for this purpose.

"The bottom of the callusing bed is first covered with 2 or 3 inches of sand. The bundles of grafts are then placed in a row along one end of the bed, and sand well filled in around them. The bundles should be placed in a slightly inclined position with the scions uppermost, and the sand should be dry enough so that it sifts in between the grafts in the bundle. The bundles of grafts are then covered up completely with sand, leaving it at least 2 inches deep above the top of the scion. Another row is then placed in the same manner until the bed is full. Finally a layer of 2 or 3 inches of moss or straw is placed over all.

"In the callusing bed we should endeavor to hasten and perfect the union of stock and scion as much as possible while delaying the starting of the buds and the emission of the roots. The latter processes require more moisture than the formation of healing tissue, therefore the sand should be kept comparatively dry. Between 5 and 10 per cent of water in the sand is sufficient. The purer the sand the less water is necessary. There should be a little more moisture present than in the sand used for keeping the cuttings over winter. Too much moisture will stimulate the emission of roots and starting of buds without aiding the callus formation.

"All the vital processes progress more rapidly when the cuttings are kept warm. To delay them, therefore, we keep the sand cool, and to hasten them we make it warm. In the beginning of the season and up to the middle of March we keep the sand cool. This is done by keeping the bed covered during the day when the sun is shining, and uncovering occasionally at night when there is no fear of rain. If the black-and-white wagon-cover is used, the white side should be placed outward to reflect the heat. The temperature should be kept about 60° F. or lower.

"About the middle of March the temperature of the bed should be raised. This is done by removing the cover during warm days and carefully covering at night. If necessary the layer of moss or straw should be removed on sunny days and then replaced. The temperature of the sand at the level of the unions should be about 75° F. during this period. If the temperature rises higher than this, there will be a more abundant production of callus, but it will be soft, easily injured, and liable to decay.

"At the end of four weeks after warming the bed, the union should be well cemented. The callus should not only have formed copiously around the whole circumference of the wound, but it should have acquired a certain amount of toughness due to the formation of fibrous tissue. It should require a pull of several pounds to break the callus and separate stock and scion. When the callus has acquired this quality the grafts are in condition to be planted in the nursery, and may be handled without danger. If taken from the bed while the callus is still soft, many unions will be injured and the grafts will fail, or unite only on one side.

"If left as long as this in the callusing bed most of the scion buds will have started and formed white shoots. These shoots, however, should not be more than $\frac{1}{2}$ to 1 inch long. If they are longer the bed has been kept too wet or too warm. Roots will also have started from the stock, but these also should not be over $\frac{1}{2}$ inch long. The grafts should be handled as carefully as is practicable, but there is no objection to breaking off any scion shoots or stock roots which have grown too long. It is almost impossible to save them, and new ones will start after the grafts are planted, and make a perfectly satisfactory growth."

Care in the nursery.

The grafts are planted in the nursery, and are given much the same care recommended for cuttings. They may be set

in trenches made with plow or spade; or they may be planted in very shallow trenches with a dibble. After planting, the grafts are covered with an inch or two of soil, thus forming a wide ridge in the nursery row with the union of the grafts at the original level of the soil. Cultivation should begin at once and be frequent enough to prevent the formation of a crust, in order that the young shoots may not have difficulty in forcing their way through the soil. Roots start on the cions sooner than on the stock, the soil being warmer at the surface, and help sustain the cions until the stocks are well rooted, at which time all roots started on the cion are removed, and at the same time the tying material is cut if it has not rotted. Suckers are removed as soon as they show above ground. The grafts are dug as soon as the leaves fall and the young vines become dormant, after which they are sorted in three lots, according to size of top and root, and heeled-in in a cool moist place until they are to be planted.

Nursery versus *home-grown vines.*

The verdict of all vineyardists is that it is better to buy nursery-grown vines than to attempt to grow them. The high quality of the vines which can be purchased and the reasonable purchase price make it hardly worth while to try home-grown vines, especially since considerable investment, experience and skill are required to grow good vines.

"Pedigreed" Grape Vines

Many viticulturists, in common with orchardists, believe that their plants should be propagated only from parents which have good characters, that is, are vigorous, healthy, productive, and bear fruit of large size, perfect form, good color and good quality. They believe, in short, that varieties can be improved by bud selection. There is, however,

but little in either theory or fact to substantiate the belief of those who say that varieties once established can be improved; or, on the other hand, that they degenerate. Present knowledge and experience indicate that heredity is all but complete in varieties propagated from parts of plants. The multitude of grapes in any variety, all from one seed, are morphologically one individual. A few kinds of grapes go back to Christ's time, and these seem to agree almost perfectly with the descriptions of them made by Roman writers 2000 years ago. How, then, can the differences between vines of a variety in every vineyard in the land be explained?

Ample explanation is found in "nurture" to account for the variation in vines without involving a change in "Nature." Soil, sunlight, moisture, insects, disease, plant-food, and the stock in the case of grafted vines, give every vine a distinct environment and hence a distinct individuality of its own. Peculiarities in a vine appear and disappear with the individual. A variety can be changed temporarily by its environment, but remove the incidental forces and it snaps back into its same old self.

Heredity is not quite complete in the grape, however; for, now and then, sports or mutations appear which are permanent and, if sufficiently different, become a strain of the parent variety or possibly a new variety. There are several such sports of the Concord under cultivation. The grape-grower can tell these sports from the modifications brought about by environment only by propagation. If a variation is transmitted unchanged through successive generations of the grape, as occasionally happens, it may be looked on as a new form. "Pedigreed" vines, then, should be subject to a test of several generations in an experimental vineyard before the grape-grower pays the price demanded for the supposed improvement.

PLATE IV. — A well-tilled vineyard of Concords.

CHAPTER IV

STOCKS AND RESISTANT VINES

PHYLLOXERA, a tiny root-louse, made its appearance in France in 1861 and began multiplying with a fury unparalleled in the insect world. By 1874, the pest had become so widespread in Europe that it threatened the very existence of the great vineyard industry of that continent. All attempts to bring the pest under control failed, although the French government offered a reward of 300,000 francs for a satisfactory remedy. Numerous methods of treating the soil to check the ravages of the insect were tried, also, but none was efficacious. Finally, it dawned on European vineyardists that phylloxera is not a scourge in America, its habitat, and that European vineyards might be saved by grafting Vinifera vines on the roots of immune American grapes. At once the reconstruction of vineyards in Europe was begun by grafting the grapes on phylloxera-resistant roots. Meanwhile, consternation spread to California when it was discovered that phylloxera was running riot in some of the vineyards of the Pacific slope; however, with the knowledge derived from viticulturists in Europe, they too began reconstructing vineyards on immune roots, without the same success as the Europeans, it is true, but with such measure of success that it soon became the approved method of growing grapes in this great region.

Through the use of resistant stocks, phylloxera is now defied in Vinifera regions. Millions of American stocks are annually struck at home, in Europe and wherever Vinifera grapes are grown, to be top-worked with varieties susceptible to phylloxera. Seldom has mastery over a pest been so complete; but, to

triumph over the tiny insect, the industry has had to be revolutionized. Resistant stocks, in their turn, brought innumerable new problems, many of which are still unsolved. Investigations and experiences in rehabilitating vineyards have been carried on for forty years, the results set forth in books and bulletins and yet there are many problems to be solved. The grape-grower in regions infested with phylloxera is always under the necessity of taking advantage of the latest demonstration of practices in the use of resistant stocks. These practices are best studied in the experiments of state experiment stations and the United States Department of Agriculture, and in the vineyards of leading grape-growers, since even those most needing elucidation can be but briefly discussed in the following paragraphs.

The wild vines of a species are always seedlings and are hence exceedingly variable. The first vineyards of resistant stocks were vines grafted on stocks of wild vines, and the results were very unsatisfactory; for, naturally, there was divergence in many characters and especially in the vigor of the vines. Also, there was difficulty in grafting, since some wild vines are stout and others slender; some bear grafts well, while others do not. It soon became apparent that to succeed, varieties must be selected from the different species for vineyard work. The great task of the experimenter and grape-grower, therefore, has been to select varieties of the several species sufficiently resistant, vigorous and otherwise possessed of characters fitting them to become good stocks. Out of vast numbers tested, a few are now generally recognized as best for the several groups of Vinifera grapes and the several distinct regions in which these grapes are grown.

Resistant species and varieties.

The reconstruction of phylloxera-ridden vineyards by the use of resistant stocks is possible only because some species

and varieties are, as has been said, more resistant to the root-louse than others. All degrees of resistance exist, as would be suspected, from immunity to great susceptibility. It is obvious that the foundation of the art of growing resistant vineyards is exact knowledge of the immunities and susceptibilities of the many varieties and species of grapes. From the first use of resistant vines, experimenters everywhere have set themselves at work to determine not only what the most resistant vines are, but what the causes and conditions of immunity. In spite of a wealth of empirical discoveries as to what grapes can best resist the root-louse, causes and most of the conditions of immunity are still little understood. Definite, useful knowledge, so far, goes little further than the establishment of lists of species and varieties, the latter subject to change, that are most useful in setting resistant vineyards.

Phylloxera does little damage to species of Vitis native to the same general region in which the pest has its habitat, but nevertheless there are some differences in resistance in American grapes. Munson, one of the best American authorities on the resistance of species to phylloxera, says:[1] "Rotundifolia is entirely immune, then Rupestris, Vulpina, Cinerea, Berlandieri, Champini, Candicans, Doaniana, Æstivalis and Lincecumii are so high in resistance as to be practically uninjured, though they may be attacked, while Labrusca is low in resistance and is much weakened in clay soils, if infested, and Vinifera is entirely non-resistant." Some of these species are hard to propagate and difficult to suit in soil and climate so that but two of them are much used for resistant stocks. The two most used are Rupestris and Vulpina (Riparia), of both of which there are varieties which give satisfaction. Bioletti, a leading authority on resistant stocks in California, says:[2]

[1] Munson, T. V. *Foundations of American Grape Culture*, 217. 1909.

[2] Bioletti, Frederic T. *Calif. Exp. Sta., Bul. 180:* 96–97. 1906.

"Varieties of resistant stocks which will in all probability be used in California are Rupestris St. George (du Lot), Riparia × Rupestris 3306, Riparia × Rupestris 3309, Riparia Solonis 1616, Mourvèdre × Rupestris 1202, Aramon × Rupestris 2, Riparia gloire, and Riparia grande glabre. These are all varieties which have given excellent varieties for years in Europe, and have all been tested successfully in California. Among them are varieties suitable for nearly all the vineyard soils of California, with perhaps the exception of some of the heavier clays.

"The only one of these varieties which has been planted extensively in California is the Rupestris St. George. There can be little doubt, however, that it will fail to give satisfaction in many soils, and though we may not find something better for all our soils it is probable that we will repeat the experience of Southern France and find that in most soils there is some other variety that gives better results. Without attempting to describe these varieties, but to give some idea of their merits and defects and of the soils most suited to each, the following indications are given, based principally on the opinions of L. Ravaz and Prosper Gervais, and on a still limited experience in California:

"The Rupestris St. George is remarkably vigorous and grows very large, supporting the graft well even without stakes. It roots easily and makes excellent unions with most vinifera varieties. It is well suited to deep soils where its roots can penetrate. Its defects are that it is very subject to root-rot, especially in moist soils; it suckers badly and it suffers from drought in shallow soils. Its great vigor produces coulure with some varieties and often necessitates long pruning.

"In moist or wet soils 1616 or 3306 had given better results in France and gives indications of doing equally well here. In drier soils 3309 will probably be found preferable.

"Aramon Rupestris No. 2 is suited to the same soils as Rupestris St. George, and does particularly well in extremely

gravelly soils. It has some of the defects of the St. George and is moreover more difficult to graft, and its only advantage in California is that it is rather less susceptible to root-rot.

"There are no better resistant stocks than Riparia gloire and Riparia grande glabre, wherever they are put in soils that suit them. They do well, however, only in deep, rich, alluvial soils which are neither too wet nor too dry. Their grafts are the most productive of all, and ripen their grapes from one to two weeks earlier than the grafts on St. George. Their principal defect is that they are very particular as to the soil, and they never grow quite as large as the cion. The gloire is the most vigorous, and the difference of diameter is less with this variety than with any other Riparia.

"The Mourvèdre × Rupestris 1202 is extremely vigorous, roots and grafts easily, and is well adapted to rich, sandy and moist soils. In drier and poorer soils its resistance is perhaps not sufficient.

"The most promising varieties for general use at present seem to be the two hybrids of Riparia and Rupestris, 3306 and 3309. They have great resistance to the phylloxera, root and graft almost as easily as St. George, and are quite sufficiently vigorous to support any variety of vinifera. The former is more suited to the moister soils and wherever there is danger of root-rot, and the latter to the drier soils. In general, they are suited to a larger variety of soils and condition than perhaps any other varieties.

"Riparia gloire should be planted only on rich, deep alluvial soil containing an abundance of plant food and humus, what would be called good garden land, such as river bank soil not liable to overflow.

"In most other soils Riparia × Rupestris 3306 is to be recommended, except those that are rather dry, where 3309 is to be preferred, or those which are very wet, where Solonis × Riparia 1616 is surer to give good results."

The value of a species or variety for a resistant stock may be judged somewhat by the visible effect of the phylloxera on the roots of the vines. On susceptible species, the punctures of the insects rapidly produce swellings which vary in size and number in accordance with resistance of the species. Technically, the first swelling on the young tender rootlets of the vine is called a nodosity. The presence of a few nodosities on the root system does not indicate that a vine is not a valuable resistant stock. When the nodosity begins to decay and becomes of a cancerous nature, it is called a tuberosity. These tuberosities decay more or less rapidly and deeply, and when they rot deeply cause enfeeblement or death to the vine. Thus, on Vinifera varieties the tuberosities are several times larger and decay sets in much more quickly than on American species which show these tuberosities. Ratings as to resistance of species are usually made from the size and number of the tuberosities, though when these are found producing a scab-like wound which scales off, there may be high resisting power.

In order to convey with some degree of definiteness the power of resistance to phylloxera, an arbitrary scale has been agreed on by viticulturists. In this scale, maximum resistance is indicated by 20 and minimum by 0. Thus, the resisting power of a good Vulpina is put as 19.5 and that of a poor Vinifera variety as 0.

Adaptations of Resistant Stocks to Soils and Climates

Resistance, of course, counts for naught in a stock which comes from a species unsuited to the soil and climate or other circumstances of the locality in which the vineyard is to be planted. The several species used for stocks differ widely in the requirements affecting growth so that the grower must make certain that the resistant stock he selects will find congenial surroundings. Stocks in congenial circumstances are

frequently more resistant than others inherently more resistant, but which are not otherwise adapted to the particular conditions of the vineyard. Species of grapes vary greatly in their root systems, some having thick, others slender roots; the roots of some are soft, of others hard; some have roots going down deeply, others are almost at the surface of the ground. Manifestly these various root-forms are but adaptations to loose and heavy, dry and moist, deep and shallow soils, or to some circumstance of climate. A vine bruised by adversity is in no condition to withstand phylloxera. Therefore, since the adaptability of a variety to a soil or climate may be changed by the stock, the adaptations of stocks to soils and climates must have attention.

Affinity of stock and cion.

Different varieties of grapes do not behave alike on the same stocks, and different stocks may affect varieties differently. Even when the kinship is close, some grapes resist all the appliances of art to make a successful union; while, on the other hand, quite distinct species often seem foreordained to be joined. For example, Rotundifolia, which has the highest resistance to phylloxera of any species, is useless as a stock because it is impossible to graft any other grape on it, while Vulpina and Rupestris unite readily with varieties of Vinifera, the slight decrease in the vigor of the grafted vines serving oftentimes to increase fruitfulness. Something more is necessary, then, than botanical kinship. Just what is necessary, no one knows, beyond: that there must be conformity in habit between stock and cion; that the two must start in growth at approximately the same time; and that the tissues must be sufficiently alike that there be proper contact in the union. Yet these facts do not sufficiently explain all of the affinities and antipathies which species and varieties of grapes show to each other. Unfortunately, the grape-grower has had but

little to guide him in selecting stocks and has had to learn by making repeated trials.

Proper Planting of Grafted Vines

Europeans and Californians long ago learned that failures with grafted vines often came from setting the vines too deep in the soil, the result being that the cions struck root and became independent, whereupon the stock dies or becomes so moribund that the beneficial effects are lost. There are grape-growers who argue that it is beneficial to the vine to have roots from both stock and cion, but experience and experiments very generally teach the contrary, it being found that in most grafts the cion roots grow more vigorously than stock roots and eventually starve out the latter. The disastrous effects of cion-rooting are often to be found, also, when grafting has been done on old vines in the vineyard; and, again, when the graft is too close to the root system.

Another cause of failure is that different stocks require that the vineyard soil be treated differently, especially at planting time. Vulpina stocks require that the soil be much more deeply plowed than for Viniferas on their own roots, since Vulpinas are deep-rooted and are exacting in the depth of root-run required. Those who have had most experience with resistant stocks maintain that all American grapes require rather deeper plowing than European grapes on their own roots.

Influence of the Stocks on the Cion

Up to the present, the growing of grafted grapes has been carried on with little thought of the mutual influence of stock and cion; grapes have been grafted only to secure vines resistant to phylloxera. Yet there can be no doubt that stock and cion react on one another, and that any variety of grapes is influenced

for better or worse in characters of vine and fruit by the stock upon which it is grafted. A plant is a delicate mechanism, easily thrown out of gear, and all plants, the grape not the least, are more or less changed in the adjustments of stock and cion. One could fill a large volume on the supposed reciprocal influence of stock and cion in fruits. Space suffices, here, however, to mention only those proved and those having to do with the influence of the stock on the cion when the grape is grafted.

Influence of stocks on European grapes summarized.

Common experience in Europe and California indicates that varieties of Vinifera grapes grafted on resistant stocks which are perfectly adapted to soil and climate produce not only larger crops but sweeter or sourer grapes; that the crop ripens earlier or later; that the vine is often more vigorous; and that there are some minor differences depending on the stock used. Winemakers assert that the character of their product may be affected for better or worse by the stock. Often vines are so improved by grafting that the extra expense of the operation and of the stock is paid for; although, to be sure, about as often the effects are deleterious. The successes and failures of vineyards on resistant stocks make plain that the vine-grower must study the many problems which stocks present and exercise utmost intelligence in the selection of the proper stock.

Influence of stocks on American grapes.

No doubt American species of grapes may be as profoundly modified by stocks as the European species, but there is but little evidence on this phase of grape-growing to be drawn from the experience of vineyardists. One rather conclusive experiment, however, shows that American grapes may be improved by growing them on stocks which give them better adaptations to their environment. The experiment was tried in the Chau-

tauqua grape-belt in western New York by the New York Agricultural Experiment Station. The test was carried on for eleven years, during which time many interesting possibilities in grafting grapes in this region came to light. It was proved that the stock materially affects the vigor and productiveness of the vine and the quality of the grapes. The following brief account is taken from Bulletin No. 355 of the New York Station:

In this experiment a number of varieties were grafted on St. George, Riparia Gloire and Clevener stocks, and a fourth group on their own roots. The varieties grafted were: Agawam, Barry, Brighton, Brilliant, Campbell Early, Catawba, Concord, Delaware, Goff, Herbert, Iona, Jefferson, Lindley, Mills, Niagara, Regal, Vergennes, Winchell and Worden. The planting plan and all of the vineyard operations were those common in commercial vineyards.

Yearly accounts of the vineyard show that the vines passed through many vicissitudes. The experiment was started in 1902 when St. George and Riparia Gloire stocks from California were set and grafted in the field. Many of these died the first year. The winter of 1903–04 was unusually severe, and many more vines were either killed or so severely injured that they died during the next two years. The vines on St. George, a very deep-rooting grape, withstood the cold best. Fidia, the grape root-worm, was found in the vineyards early in the life of the vines and did much damage in some years. In the years of 1907 and 1909 the crops were ruined by hail.

But despite these serious setbacks it was evident throughout the experiment that the grafted grapes made better vines and were more productive than those on their own roots. As an example of the differences in yield, a summary of the data for 1911 may be given. In this year, an average of all the varieties on own roots yielded at the rate of 4.39 tons to the acre; on St. George, 5.36 tons; on Gloire, 5.32 tons; on Clevener, 5.62

tons. The crops on the grafted vines were increased through the setting of more bunches and the development of larger bunches and berries.

The grapes on the vines grafted on Gloire and Clevener ripened a few days earlier than those on their own roots, while with St. George a few varieties were retarded in ripening. Changing the time of maturity may be very important in grape regions where there is danger of early frost to late-ripening sorts, and where it is often desirable to retard the harvest time of early grapes.

In the behavior of the vines, the results correspond closely with those given for yields. In the growth ratings of varieties on different stocks, the varieties on their own roots were rated in vigor at 40; on St. George, at 63.2; on Gloire, at 65.2; on Clevener, at 67.9. There is no way of deciding how much the thrift of the vines depends on adaptability to soil, and how much on other factors. Since all of the varieties were more productive and vigorous on grafted vines than on their own roots it may be said that a high degree of congeniality exists between the stocks and varieties under test.

The experiment suggests that it would be profitable to grow fancy grapes of American species on grafted vines, and that it is well within the bounds of possibility that main-crop grapes can be grafted profitably. In the general tuning-up of agriculture now in progress, it may be expected that soon American as well as European varieties of grapes will be grown under some conditions and for some purposes on roots other than their own.

Direct Producers

Attempts innumerable have been and are still being made to secure, by hybridizing *V. vinifera* and American species of grapes, varieties that will resist phylloxera, the mildew and black-rot. The grapes of this continent are relatively immune

to all of these troubles, and if hybrids could be obtained to produce directly, without grafting, grapes with the good qualities of the Viniferas — in short, European grapes on American vines — the cultivated grape flora of the whole world might be changed. So far, a "direct producer" that is wholly satisfactory in either Europe or California has not been found for the wine or raisin industries, although a number of varieties are rated as very good table grapes, and a few are used in wine-making. The best of the direct producers are Lenoir, Taylor, Noah, Norton's Virginia, Autuchon, Othello, Catawba, and Delaware.

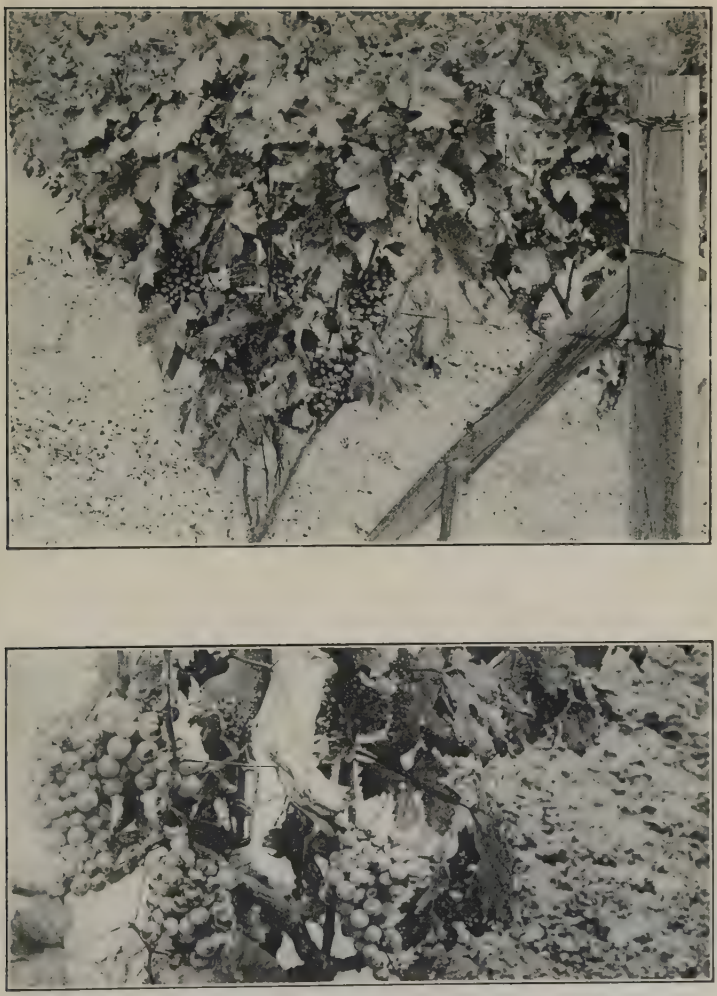


PLATE V. — Vinifera grapes grown out of doors in New York. *Top*, Malvasia; *bottom*, Chasselas Golden.

CHAPTER V

THE VINEYARD AND ITS MANAGEMENT

A VINEYARD is more artificial than other plantations of fruits, since the vine requires greater discipline under cultivation than tree or bush. Yet greater art is required only when the attempt is made to grow the grape to perfection, for the vine bears fruit if left to indulge in riotous growth wheresoever it can strike root. Vineyard management, therefore, may represent the consummate art of three thousand or more years of cultural subserviency; or it may be so primeval in simplicity as to approach neglect. The grape is so wonderfully responsive to good care, however, that no true lover of fruit will profane it with neglect, but will seek, rather, to give it a favorable situation, its choice of soils and such generous care as will insure strong, vigorous, productive vineyards of choicely good fruit.

Grape-growing is a specialists' business, for the culture of the grape is unlike that of any other fruit. The essentials of vineyard management, however, are easily learned. Indeed, care of the vine comes almost instinctively; for the grape has been cultivated since prehistoric times and the races of the world are so familiar with it through sacred literatures, myths, fables, stories and poetry, that its care is prompted by natural impulse. The grape has followed civilized man so closely from place to place through the temperate climates of the world, that rules and methods of culture have been developed for almost every condition under which it will grow, so that every grape-grower may profit by the successes and failures of the generations

that preceded him. Grape-growing is not, however, an art wholly governed by rules of the past to be carried on by common laborers who use hands only, but is one in which its followers may make use of science and may put thought, skill and taste into their work.

Laying Out the Vineyard

Vineyards are laid out for the most part after accepted patterns for each of the great grape regions of America. The vines are always planted in rectangles, usually at a less distance apart in the rows than the rows are from each other, but sometimes in squares. Pride in appearance and convenience in vineyard operations make perfect alignment imperative. Many varieties of grapes, especially of American species, are partially self-sterile, so that some varieties must have others interplanted with them for cross-pollination. This is usually done by setting alternate rows of the variety to be pollinated and the cross-pollinator. All self-fertile varieties are set in solid blocks because of convenience in harvesting.

Direction of rows.

Some grape-growers attach considerable importance to the direction in which rows run, holding either that the full blaze of the sun at mid-day is desirable for vine, soil and fruit, or that it is detrimental. Those who desire to provide fullest exposure to the sun plant rows east and west when the distance between vines is less than the distance between rows; north and south when vines are farther apart in the row than the rows are from each other. When shade seems more desirable, these directions are reversed. Most often, however, the rows are laid out in accordance with the shape of the vineyard; or, if the land is hilly, the rows follow the contour of the declivities to prevent soil erosion by heavy rains.

Alleys.

For convenience in vineyard operations, especially spraying and harvesting, there should always be alleys through a vineyard. On hilly lands, the alleys are located to secure ease in hauling; on level lands they are usually arranged to cut the vineyards into blocks twice as long as wide. An alley is usually made by leaving out a row of vines. Many vineyards are laid out with rows far enough apart so that alleys are not needed.

Distances between rows and plants.

There are great variations in the distances between rows and plants in different regions, and distances vary somewhat in any one region. Distances are influenced by the following considerations: Rich soils and large vigorous varieties require greater distances than poor soils and less vigorous varieties; sometimes, however, it is necessary to crowd a variety in the vineyard so that by reducing its vigor fruitfulness may be promoted. Usually the warmer the climate, or the exposure, the greater should be the distance between vines. Very often the topography of the land dictates planting distances. But while taking in account the preceding considerations, which rightly suggest the distances between plants in the row, convenience in vineyard operations is the factor that most often fixes the distance between rows. The rows must be far enough apart in commercial vineyards to permit the use of two horses in plowing, spraying and harvesting.

Planted in squares, the distance varies from seven feet in garden culture to nine feet in commercial vineyards for eastern America. More often, however, the rows are eight or nine feet apart, with the vines six, seven or eight and in the South ten or twelve feet apart in the rows. Planting distances are less, as a rule, on the Pacific slope than in eastern regions; that is, the distances between the rows are the same, to permit work

with teams, but the distance between plants in the rows is less, sometimes being no greater than three and a half or four feet. The rank-growing Rotundifolias of the southern states need much room, nine by sixteen feet being none too much. Sunshine must govern the distance apart somewhat. Grapes picked in the pleached alleys of closely set vineyards of the North and East are few, small and poor; farther south, shade from the vines may be a requisite for a good crop.

The number of vines to the acre must be determined before growing or buying plants. This is done by multiplying the distance in feet between the rows by the distance the plants are apart in the row, and dividing 43,560, the number of square feet in an acre, by the product.

Preparation for Planting

It is impossible to put too much emphasis on the necessity of thorough preparation of the land before planting the grape. Extra expenditure to secure good tilth is amply repaid by increased growth in the grape, and all subsequent care may fail to start the vines in vigorous growth if the land is not in good tilth preparatory to planting. The vineyard is to stand a generation or more, and its soil is virtually immortal, two facts to suggest perfect preparation. The land should be thoroughly well plowed, harrowed, mixed and smoothed. The better this work is done, the greater the potentialities of the vineyard. Here, indeed, is a time to be mindful of the adage which comes from Cato, a sturdy old Roman grape-grower of 2000 years ago: "The face of the master is good for the land."

Preparation is a series of operations in which it is wise to take advantage of time and begin a year before the vines are to be set. The land must be put in training to fit it for the long service it is to render. The two great essentials of preparation are provision for drainage and thorough cultivation. Both,

to be performed as the well-being of the grape require, take time, and a year is none too short a period in which to do the work. Moreover, newly drained and deeply plowed land requires time for frost, air, sunshine and rain to sweeten and enliven the soil after the mixture by these operations of live topsoil with inert subsoil.

Drainage.

The ideal soil, as we are often told, resembles a sponge, and is capable of retaining the greatest possible amount of plant-food dissolved in water, and at the same time is permeable for air. This ideal, sponge-like condition is particularly desirable for the grape, especially native species, because the vines of all are exceedingly deep-rooted. Moreover, grapes thrive best in a warm soil. While, therefore, the roots may make good use of nutritious solutions, if not too diluted, in an undrained soil, they suffocate and do not receive sufficient bottom heat. It must be made emphatic that the grape will not thrive in water-logged land.

Unless the land is naturally well drained, under-drainage must be provided as the first step in the preparation of land for the vineyard. Tile-draining is usually best done by those who make land-draining their business, but information as to every requirement of land and detail of work may be secured from many texts, so that grape-growers may perform the work for themselves. In concluding the topic, the reader must be reminded that high and hill lands are not necessarily well drained, and low lands are not necessarily wet even if the surface is level. Often hilltops and hillsides need artificial draining; much less often valley lands and level lands may not need it. To assume, too, that gravelly and shaley soils are always well drained often leads directly contrary to the truth. Sandy and gravelly soils need drainage nearly as often as loamy and clayey ones.

Following tiling, if the land has had to be under-drained, the vineyard should be graded to fill depressions and to make the surface uniform. Usually this can be done with cutaway, tooth or some other harrow, but sometimes the grader or road-scraper must be put in use.

Fitting the land.

Preparatory cultivation should begin the spring preceding planting by deep plowing. If the land has been used long for general farming so that a hard plow-sole has been formed by years of shallow plowing, a subsoil-plow should follow in the furrow of the surface plow, although it is seldom advisable to go deeply into the true hardpan. Fitting the land must not stop here but should continue through the summer with harrow and cultivator to pulverize the soil almost to its ultimate particles. Such cultivation can be sufficiently thorough, and be made at the same time profitable, by growing some hoed crop which requires intensive culture. If the soil lacks humus, a cover-crop of clover or other legume might well be sown in early summer to be plowed under in late fall. Or, if stable manure is available, this generally should be applied the fall before planting. Stable manure applied at this time to a soil inclined to be niggardly puts an atmosphere in the forthcoming vineyard wholly denied the grower who must rely on commercial fertilizers.

The land should be plowed again, deeply and as early in the fall as possible, harrowed thoroughly, or possibly cross-plowed and then harrowed. The land must go into the winter ready for early spring planting and the fall work must be done promptly and with a sturdy team and sharp, bright tools. The grower must keep in mind that no opportunity will offer during the life of the vineyard to even up for slackness in the start and that a vineyard of dingy, unhappy vines may be the result of neglect at this critical time. Good tilth should proceed until

the earth is fairly animated with growth when the vines are planted. Plate II shows a piece of land well fitted for planting.

Marking for planting.

Given level land, a well-made marker, a gentle team and a careful driver with a surveyor's eye, and a vineyard may be marked for planting with a sled-marker, a modified corn-marker or even a plow. Some such marker method is commonest in use in laying out vineyard rows, but it is patent to the eye of every passer-by in grape regions that the commonest method is not the best to secure perfect alignment of row and vine. The combination named for good work with any of the marker methods is found too seldom. If the marker method is used, it is put in practice as follows: The rows being marked at the distance decided on, a deep furrow is plowed along the row by going both ways with the plow; this done, small stakes are set in the furrow at the proper distances for the vines, taking care to line them both ways. Planting holes are thus dug in the furrow with the stakes as a center.

Marking by means of a measuring wire or chain is the best method of locating vines accurately in a vineyard. The measuring wire varies according to the wishes of the user from two to three hundred feet or may be even longer. The best wires are made of annealed steel wire about an eighth of an inch in diameter. At each end of the wire is a strong iron ring to be slipped over stakes. The wire is marked throughout its length by patches of solder at the distances desired between rows of vines; to make these places more easily seen, pieces of red cloth are fastened to them. Sometimes this measuring wire is made of several strands of small wire, giving more flexibility and making marking easier, since by separating the strands at the desired points, pieces of cloth may be tied to mark distances.

In using the wire, the side of the vineyard which is to serve as the base of the square is selected and the wire is stretched,

leaving at least one rod from road or fence for a headland. With the wire thus stretched, a stake is placed at each of the distance tags to represent the first row of vines. Beginning at the starting point, sixty feet are measured off in the base line and a temporary stake is set; eighty feet at a right angle with the first line are then measured off at the corner stake, judging the angle with the eye; then run diagonally from the eighty-foot stake to the sixty-foot stake. If the distance between the two stakes is one hundred feet, the corner is a right angle. With the base lines thus started at right angles to each other, one can measure off with the measuring wire as large an area as he desires by taking care to have the line each time drawn parallel with the last, and the stakes accurately placed at the marking points on the wire.

Still another method which may be put to good use in laying out a vineyard, especially if the vineyard is small, is to combine measure and sight. The distances about the vineyard are measured and stakes set to mark the ends of the rows around the area. Good stakes can be made from laths pointed at one end and whitewashed at the other. A line of stakes is then set across the field each way through the center, in places, of course, which the two central rows of vines will fill. When these are in place, if the area is not too large or too hilly, all measurements can be dispensed with and the vines can be set by sighting. A man at the end of the row has three laths to sight by in each row and a second man should drive stakes as directed by the sighter. Accurate work can be done by this method, but it requires time, a good eye and much patience in the man who is sighting.

Selecting and Preparing the Vines

Young grape vines covet life, for they are usually vigorous and not easily injured. Hence, the plants may be brought

from a distance without fear of loss. The local nurseryman is, however, a good adviser as to varieties if he is honest and intelligent, and, other things equal, he should be patronized. But if the grower's needs cannot be met at home, he should not hesitate to seek a nurseryman at a distance. This is more necessary with the grape than other fruits because young grapes are well and cheaply grown in certain localities only. With the grape, as with all fruit plants, it is much better to buy from the grower than from tree peddlers.

Selecting vines.

Unless the buyer knows what he wants, selecting vines is gambling pure and simple. Fortunately, there are several marks of good vines very helpful to those who know them. One should first make sure that the roots and tops are alive to the remotest parts. The vines should have a good clean, healthy look with trunk diameter large enough to indicate vigorous growth, and an ample spread of roots. Large size is not as desirable as firm, well-matured wood and an abundance of roots. Vines with internodes of medium length for the variety are better than those with great length or very short internodes. Such precautions as are possible should be taken to insure varieties true to name, although here the reputation of the nurseryman must be depended on except for the few varieties which may be known at sight in the nursery.

First-grade one-year-old vines are usually better than two-year-olds. Stunted vines are not worth planting and two-year-old vines are often stunted one-year-olds. A few weak-growing varieties gain in vigor if allowed to remain in the nursery two years — three years, never.

Handling and preparing the vines.

The better vines are packed, transported and cared for in the field, the quicker will the roots take hold and the vines

make the vigorous start on which so much depends. The nurseryman should be requested not to prune much before packing and to pack the vines well for shipping. The vines should be heeled-in as soon as they reach their destination. If the vines are dry on arrival, they should be drenched well before heeling-in. It sometimes happens that the vines are shriveled and shrunken from excessive drying, in which case the plants often may be brought back to plumpness by burying them root and branch in damp earth, to remain a week or possibly two. To heel-in, a trench should be double furrowed in light, moist soil, the vines spread out in the trench two or three deep, and then earth shoveled over the roots and half the tops, sifting it in the roots, after which the soil is firmed. The vines may thus be kept in good condition for several weeks if need arises.

The vines are prepared for planting by cutting away all dead or injured roots and shortening-in the healthy roots. Grape roots can be cut severely if healthy stubs remain, the removal of small roots and fibers doing no harm, since fibers are of value only as indicating that the vine is strong and vigorous. Fresh fibers come quickly from stout, healthy roots. Most of the fibers of a transplanted vine die, and laying them out in the hole to preserve them, as is so often recommended, is but a useless burial rite. On good healthy vines, the stubs of the roots, when cut back, will be four to eight inches in length. The root system having been considerably pruned, the reciprocity between roots and tops must be taken into account and the top pruned accordingly. To reduce the work of the leaves to harmonize with the activities of the roots, the top should be pruned to a single cane and two, never more than three, buds. The vine is now ready for planting and, the soil being in readiness, planting should proceed apace.

PLATE VI. — Black Hamburg ($\times \frac{1}{2}$).

Planting

The dangers and difficulties of planting hardwooded plants are greatly exaggerated. The tyro, in particular, is impressed with his responsibilities at this time, and often sends a hurry-up call to experiment station or nurseryman to "send him a man to plant." If the land is properly prepared and the plants in good condition, the operation of planting is easily, quickly and safely accomplished. There is no need, in planting the vine, of such puttering overniceties as laying out the roots to preserve the fibers, watering each vine as it is set, inserting the vine in a gingerly fashion to make sure that it stands in its new abode as it stood in the old, or puddling the roots in pail or tub of water. On the other hand, the slap-dash method of a Stringfellow who cuts off all small roots and uses a crow-bar in place of a spade is not doing duty by the plant, and burying the roots deep in the earth or covering them close to the surface is courting failure.

Digging the holes.

This is a simple task in land in good tilth. The holes need only be large and deep enough to hold the roots without undue cramping. Herein is again manifested the wisdom of thoroughly preparing the land; for, in well-prepared land, the hole is really as large as the vineyard. Even in the condition of poor tilth, deep holes are often a menace to the life of the plant, especially if drainage is not provided, for the deep hole becomes a tub into which water pours and stands to soak the roots of dying vines. An extra spurt in digging holes cannot take the place of perfect fitting of the land.

There is nothing to commend the practice of digging holes in a leisure time that all may be ready when the time to plant arrives. The vines will strike root best in the freshly turned, moist soil of newly dug earth, which can be firmly set about

the roots when the vine is planted. Neither is time saved in digging beforehand, for the sun-baked and rain-washed sides of holes long dug would surely have to be pared afresh. It is, however, quite worth while to throw the surface soil to one side and that lower to the other, that a spadeful of moist, virile, surface soil may be put next to the roots.

There are, no doubt, some soils in which the holes might be blasted out with dynamite, as, for instance, in a shallow soil with the hardpan near the surface and good subsoil beneath. It is very questionable, however, whether these defective soils should be used for commercial plantings as long as there still remain unplanted many acres in all grape regions of good deep land for the grape. To such as are attracted by "dynamite farming," minute descriptions of methods of use of dynamite and even demonstrations may be secured from manufacturers of the explosive.

Time to plant.

The best time to plant the vine in cold climates is early spring, when sun and showers arouse the spirit of growth in plants, and nutritive solutions proceed quickly and unerringly to their preappointed places. At this time, the much mutilated vine can undertake best the double task of making fresh roots and opening the dormant leaves. Fall planting puts forward the work, thus diminishing the rush of early spring when vineyard operations crowd, and, no doubt, when all is favorable, enables the vines to start a little more quickly. However, there are frequently serious losses from planting in the fall. In cold winters the grip of frost is sufficient to wrench the young vine from its place and sometimes all but heaves it out of the soil. There is, also, great liability of winter-killing in vines transplanted in the autumn, not because of greater tenderness of the plant, but because of greater porosity of the loosened soil which enables the cold to strike to a greater depth. These

two objections to fall planting can be overcome largely by mounding up the earth so as practically to cover the vines, leveling the mound in early spring; but this extra work more than offsets the labor saving in fall planting.

In climates in which the soil does not freeze in the winter, the vines may be set in the autumn if all is favorable. Often, however, conditions are not favorable to fall planting in warm climates, since autumn rains frequently soak the soil so that it cannot be placed properly about the roots; and, moreover, in a cold, water-logged soil the inactive roots begin to decay; or the soil may be too dry for fall planting. Under such conditions, it is often better to delay planting in warm climates until spring when better soil conditions can be secured. Fall or spring, the soil should be reasonably dry, warm and mellow when the work is done. The best time to plant must necessarily vary from year to year, and the vineyardist must decide exactly when to undertake planting in accordance with the conditions of soil and weather, mindful that the Psalmist's injunction that there is "a time to plant, and a time to pluck up that which is planted" is subject to several conditions requiring judgment. The grape puts out its leaves late in the spring, making the temptation great to delay planting; late-set plants, however, need special care lest they suffer from the summer droughts which annually parch the lands of this continent.

The operation of planting.

All being in readiness, planting proceeds rapidly. A gang of four men work to advantage. Two dig holes, a third holds the vines and tramps the earth as the remaining man shovels in earth. Except in large vineyards, four men are seldom available, and gangs of two or three must divide the work among its members as best suits conditions. A tree-setting board is not needed in planting grapes, although some growers use it. The man who holds the vines in the hole and tramps

as the shoveler fills, must align the plant after the stake is removed and see that it stands perpendicularly in the hole. The stake, a lath, is set in its old place in the hole to serve as a support for the growing vine and to mark it so that the cultivator does not pull up the young plant. The soil must be set firm about the roots of the plant, but zeal in tramping should diminish as the hole is filled, leaving the topsoil untramped, smooth, loose and pulverized, a dust mulch — the best of all mulches — to prevent evaporation.

The depth to which vines should be set is a matter of controversy. This should be governed by the soil more than by any other factor, although some varieties need a deeper root-run than others. The rule to plant to the depth the vine stood in the nursery row is safe under most conditions, although in light, hungry or thirsty soils the roots should go deeper; and, on the other hand, in heavy soils, not so deep. Deep planting is a more common mistake than shallow planting, for roots under most conditions stand exposure better than internment, going down being more natural than coming up for a root seeking a place to its liking.

Watering at planting is necessary only when the land is parched with drought or in regions in which irrigation is practiced. When necessary, water should be used liberally, at least a gallon or two to a vine. After the earth has been firmed about the roots and the hole is nearly filled, the water should be poured in and the hole filled without more firming. Under dry weather conditions, some prefer to puddle the roots; that is, to dip them in thin mud and plant with the mud adhering. In making the puddle, loose loam and not sticky clay is used, as clay may bake so hard as to injure the roots. With puddling, as with watering, the surface soil should be left loose and soft without traces of the puddling below.

Manure or fertilizer about the roots or even in the hole are not necessary or even desirable. If the soil is to be enriched

at all at planting time, the fertilizer should be spread on the surface to be cultivated in or to have its food elements leak down as rains fall. In land in which the providential design for grapes is plainly manifested, the vine at no time responds heartily to fertilizers, the good of stable manure probably coming for the most part from its effects on the texture and water-holding capacity of the soil. The newly set plant is not in need of outside nourishment; to put rank manure or strong commercial fertilizers about the roots of a young newly set vine is plant infanticide.

Care of Young Vines

Virgil calls the period in the life of the vine between the setting and the first vintage, the "tender nonage," and tells us that at this time the vines need careful rearing; so they do, now as then, American grapes as well as the grapes of ancient Rome. Fortunately, any departure from normal well-being is easily told in the grape, for the color of the leaf is as accurate an index to the health and vigor of the vine as the color of the tongue or the beat of the pulse in man. A change of color from the luxuriant green of thrifty grape foliage, especially the yellow hue indicating that the leaf-green is not functioning properly, suggests that the vines are sick or need nursing in some detail of care. When all goes well, however, the amazing energy of Nature is nowhere better seen among plants than in the growth of the grape, so that much of the care is in the use of the knife; in fact, as we shall see, the grape almost lives by the knife the first two years out.

The first year.

The vines having been pruned and staked at planting, these operations need no attention in the first summer. Many varieties send up several shoots as growth starts, and, except

in the case of grafted plants and in the event of the suckers coming from the stock, these should be left to feed the vine and help to establish a good root system. Vines making a strong growth should be tied to the stake, at least the strongest shoot, to keep the wind from whipping it about and to keep the plants out of the way of the cultivator. The only knack in tying is to keep the vine on the windward side of the stake, thus saving the breaking of tying material.

The first year's pruning, though severe, is easily done. All but the strongest cane are cut out and this is pruned back to two buds, nearly to the ground, so that the vines are much as when set in the vineyard. This pruning, and that of the next two years, has as the object the establishment of a good root system and the production of a sturdy trunk at the height at which the vine is to be headed. It is important that the cane from which the trunk is to come be healthy and the wood well ripened. Pruning may be done at any time after the leaves fall, though most growers give preference to late winter. In cold climates it is a good practice to plow up to the young vines for winter protection, in which case the pruning should be done before plowing.

Every detail of vineyard management should be performed with care and at the accepted time in this critical first year. Cultivation must be intensive, insects and fungi must be warded off, mechanical injuries avoided, vines that have refused to grow must be marked for discard, and the vineyard be put down to a cover-crop in early August if it was not earlier planted to some hoed catch-crop.

The second year.

Work begins in the spring of the second year with the setting of trellis posts on which one wire is put up. The vine is not yet ready to train but the slender lath of the first season is not sufficient support, and the one wire on the future trellis

saves the expense of staking. Tying requires some care and is usually done with string or bast. As the summer proceeds, suckers from the roots are removed and some growers thin the shoots on the young vine; some think it necessary also to top the growth if it becomes too luxuriant and so keep the cane within bounds. Suckers must be cut or broken off at the points where they originate, otherwise several new ones may start from the base of the old. If the vines are topped, it must be kept in mind that summer pruning is weakening, and the tips of shoots should, therefore, be taken when small, the object being to direct the growth into those parts of the vine which are to become permanent.

Pruning, the second winter the vine is out, depends on the vigor of the plant. If a strong, healthy, well-matured cane over-tops the lower wire of the trellis, it should be cut back so that the cane may be tied to the wire; otherwise the vine should again be cut almost to the ground, leaving but three or four buds. If the cane be left, in addition to sturdiness and maturity, it should be straight, for it is to become the trunk of the mature vine. The training of the young vine is now at an end, for the next season the vine must be started toward its permanent form, instructions for which are given in the chapter on pruning.

The summer care of the vineyard does not differ materially in the second year from that of the first. Intensive cultivation continues, the vines are treated for pests and the annual cover-crop follows cultivation. Many varieties, if vigorous, will set some fruit in this second summer, but the crop should not be allowed to mature, the sooner removed the better, as fruiting at this stage of growth seriously weakens the young vines.

Catch-crops and Cover-crops

A catch-crop is one grown between the rows of another crop for profit from the produce. A cover-crop is a temporary

crop grown, as the term was first used, to protect the soil, but the word is now used to include green-manuring crops as well. Catch-crops seldom have a place in most vineyards, but cover-crops are often grown.

Catch-crops.

Catch-crops are not, as a rule, profitable in commercial vineyards; they may bring temporary profit but in the long run they are usually detrimental to the vines. It may pay and the grape may not be injured in some localities, if such truck crops as potatoes, beans, tomatoes and cabbage are grown between the rows or even in the rows for the first year and possibly the second. Land, to do duty by the two crops, however, must be excellent and the care of both crops must be of the best. Growing gooseberries, currants, any of the brambles, or even strawberries, is a poor procedure unless the vineyard is small, the land very valuable or other conditions prevail which make intensive culture possible or necessary. The objections to catch-crops in the vineyard are two: they rob the vines of food and moisture and endanger them to injury from tools in caring for the catch-crop.

Sometimes the grape itself is planted as a catch-crop in the vineyard. That is, twice the number of vines required in a row for the permanent vineyard are set with the expectation of cutting out alternate vines when two or three crops have been harvested and the vines begin to crowd. This practice is preferable to interplanting with bush-fruits, yet there is not much to commend it if the experience of those who have tried it is taken as a guide. Too often the filler vines are left a year too long with the result that the permanent vines are checked in growth for several years following. The profits from the fillers are never large, scarcely pay for the extra work, and if the permanent vines are stunted, the filler must be put down as a liability rather than as an asset.

Cover-crops.

In an experiment being conducted by the New York Agricultural Experiment Station, grapes do not give a very appreciable response to cover-crops in yield of fruit or growth of vine.[1] There seem to be no other experiments to confirm the results at the New York Station, and grape-growers nowhere have used cover-crops very generally for the betterment of their vineyards. There is doubt, therefore, as to whether grapes will respond profitably to the annual use of cover-crops in yield of fruit, which, of course, is the ultimate test of the value of cover-crops, but a test hard to apply unless the experiment runs a great number of years.

Leaving out the doubtful value of cover-crops in increasing the supply of plant-food and thereby producing an increase in yield, there are at least three ways in which cover-crops are valuable in the vineyard. Thus, it is patent to all who have tried cover-crops in the vineyard that the land is in much better tilth and more easily worked when some green crop is turned under in fall or spring; it is not unreasonable to assume, though it is impossible to secure reliable experimental data to confirm the belief, that cover-crops protect the roots of grapes from winter-killing; certainly it may be expected that a cover-crop sowed in midsummer will cause grapes to mature their wood earlier and more thoroughly so that the vines go into the winter in better condition. The only objection to be raised against cover-crops in the vineyard is that pickers, mostly women, object to the cover-crop when wet with rain or dew and usually choose to pick in vineyards having no such crop. This seemingly insignificant factor often gives the grape-grower who sows cover-crops much trouble in harvest time.

Several cover-crops may be planted in vineyards as clover,

[1] For an account of this experiment, see Bul. 381 of the N. Y. Agr. Exp. Sta., Geneva.

vetch, oats, barley, cow-horn turnip, rape, rye and buckwheat. Combinations of these usually make the seed too costly or the trouble of sowing too great. Yet some combinations of a leguminous and non-leguminous crop would seem to make the best green crop for the grape. Thus, a bushel of oats or barley plus ten pounds of clover or twenty pounds of winter vetch, a combination often used in orchards, should prove satisfactory in the vineyard. Or, doubling the amount of seed for each, these crops could be alternated, with a change in the rotation every four or six years, with cow-horn turnip or rape. Turnip and rape require at least three pounds of seed to the acre.

The cover-crop is sown in midsummer, about the first of August in northern latitudes, and should be plowed under in the fall or early spring. Under no circumstances should the green crop be permitted to stand in the vineyard late in the spring to rob the vines of food and moisture. The weather map must be watched at sowing time to make sure of a moist seed-bed. Plate III illustrates two vineyards with well-grown cover-crops.

Tillage

Grape-growers are not in the fog that befuddles growers of tree-fruits in regard to tillage. He is a sloven, indeed, who permits his vines to stand a season in unbroken ground, and there are no growers who recommend sod or any of the modified sod-mulches for the grape. Tillage is difficult in hilly regions and the operation is often neglected in hillside vineyards, as in the Central Lakes region of New York, but even here some sort of tillage is universal. The skip of a single season in tilling stunts the vines, and two or three skips in successive seasons ruin a vineyard. No one complains that grapes suffer from over-tilling as one frequently hears of tree-fruits. There is no tonic for the grape that compares with cultivation when the

leaves lack color and hang limp and the vine has an indefinable air of depression; and there is nothing better than cultivation to rouse latent vigor in a scorching summer, or when drought lays heavy on the land.

Tillage tools.

The tools to be used in tilling grapes vary with the topography of the vineyard, the kind of soil and the preferences of the vineyardist. The best tool is the one with which the ground can be well fitted at least expense. Good work in the vineyard requires at least two plows, a single-horse and a two-horse plow. The latter, except on very hilly land, should be a gang-plow. For commercial vineyards of any considerable size, several cultivators are necessary for different seasons and conditions of the soil. Thus, every vineyard should have a spring-tooth and a disc harrow, one of the several types of weeders, a one-horse and a sulky cultivator. If weeds abound, it is necessary to have some cutting tool, or an attachment to one of the cultivators, to slide over the ground and cut off large weeds. Another indispensable tool in a large vineyard is a one-horse grape-hoe, to supplement the work of which there must be heavy hand-hoes. Very often the surface soil must be pulverized, and a clod-crusher, roller or a float becomes a necessity. A full complement of bright, sharp tools at the command of the grape-grower goes far toward success in his business.

Tillage methods.

There are several reliable guides indicating when the vineyard needs to be tilled. The vineyardist who is but a casual observer of the relation of vineyard operations to the life events and the welfare of his vines will take the crop of weeds as his guide. It is, of course, necessary to keep down the weeds, but the man who waits until weeds force him to till will make a

poor showing in his vineyard. The amount of moisture in the soil is a better guide. The chief function of tillage is to save moisture by checking evaporation and to put the soil in such condition that its water-holding capacity is increased. The physical condition of the land is another guide. Tilling when the soil needs pulverizing furnishes a greater feeding surface for the roots.

Tillage begins with plowing in early spring. Whether provided with a cover-crop to be turned under or hard and bare, the land must be broken each spring with the plow. Plowing is best done by running a single furrow with a one-horse plow up to or away from the vines as occasion calls and then following with a two-horse or a gang-plow. Some growers use a disc harrow instead of the plow to break the land in the spring, but this is a doubtful procedure in most vineyards and is impossible when a heavy green-crop covers the land. Tillage with harrow, cultivator, weeder or roller then proceeds at such intervals as conditions demand, seldom less than once a fortnight, until time to sow the cover-crop in midsummer. About the time grapes blossom, the grape-hoe should be used to level down the furrow turned up to the vines in the spring plowing. Tillage should always follow a heavy rain to prevent the formation of a soil crust, this being a time when he who tills quickly tills twice. The number of times a vineyard should be tilled depends on the soil and the season. Ten times over with the cultivator in one vineyard or season may not be as effective as five times in another vineyard or another season. In some regions, as in New York, the grower is so often at the mercy of wet weather in early spring that the plowing is best done in the fall, and spring operations must then open with harrowing with some tool that will break the land thoroughly.

The depth to till is governed by the nature of the soil and the season. Heavy soils need deep tilling; light soils, shallow tilling; in wet weather, till deeply; in dry weather, lightly.

Grape roots are well down in the soil and there is little danger of injuring them in deep tillage. The depth of plowing and cultivating should be varied somewhat from season to season to avoid the formation of a plow-sole. In some regions plowing and cultivating may be made a means of combating insects and fungi, and this regulates the depth of tillage. Thus, in the Chautauqua grape-belt of western New York, the pupa of the root-worm, a scourge of the grape in this region, is thrown out and destroyed by the grape-hoe just as it is about ready to emerge as an adult to lay its eggs on the vines. In all regions, leaves and mummied grapes bearing countless myriads of spores of the mildews, black-rot and other fungi are interned by the plow and cannot scatter disease.

The time in the season to stop tillage depends on the locality, the season and the variety. It is a good rule to cease cultivation a few weeks before the grapes attain full size and begin to color, for by this time they will have weighted down the vines so that fruit and foliage will be in the way of the cultivator. In the North, cultivation ceases in the ordinary season about the first of August, earlier the farther south. Rank-growing sorts, as Concord or Clinton, do not need to be cultivated as late as those of smaller growth and scantier foliage, as Delaware or Diamond. The cover-crop seed is covered the last time over with the cultivator. Plate IV shows a well-tilled vineyard of Concords.

Irrigation

The grape, as a rule, withstands drought very well, several species growing wild on the desert's edge. Even in the semi-arid regions of the far West, where other fruits must always be irrigated, the grape often grows well without artificial watering. Irrigation is practiced in vineyards in the United States only on the Pacific slope and here the practice is not as general as with other fruit crops. Whether the grape shall be grown

under irrigation or not is a local and often an individual question answered with regard to several conditions; as the local rainfall, the depth and character of the soil, the cost of water and ease of irrigation. These conditions are all correlated and make about the most complex and difficult problem the growers of grapes in semi-arid regions have to solve. As long, however, as the grape-grower can grow fairly vigorous vines and harvest a fairly bountiful crop by natural rainfall, he should not irrigate; for, even though the crop offsets the cost, there are several objections to growing grapes under irrigation. The vines are subject to more diseases and physiological troubles; the fruit is said to lack aroma and flavor; grapes grown on irrigated land do not stand shipment well, the unduly inflated grapes often bursting; wine-makers do not like irrigated grapes as well as those from non-irrigated lands; and watery grapes from irrigated lands make inferior raisins. It is maintained, however, with a show of reason, that grapes suffer in irrigated vineyards in the ways set forth only when the vines are over- or improperly irrigated.

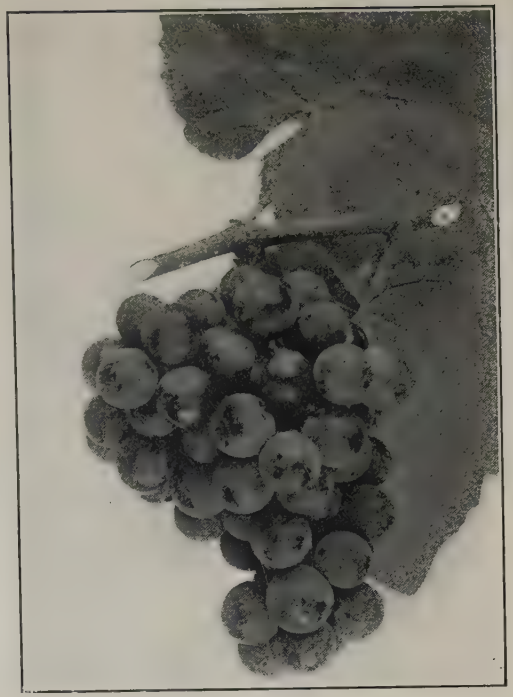
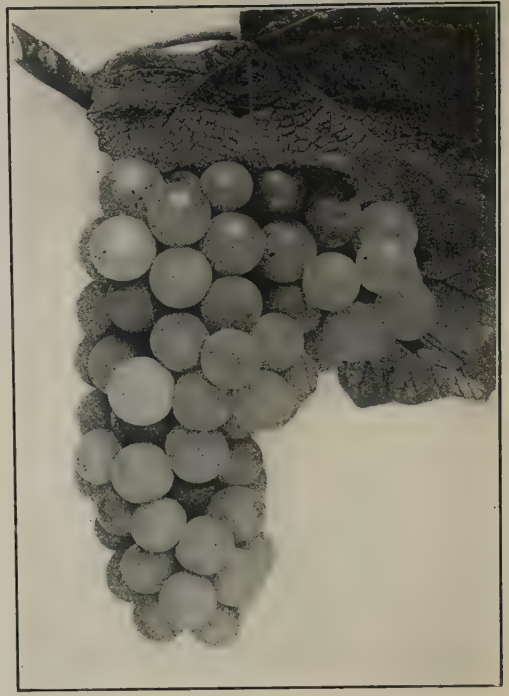


PLATE VII. — Barry ($\times \frac{2}{5}$).



Delaware ($\times \frac{2}{5}$).

CHAPTER VI

FERTILIZERS FOR GRAPES

As regards fertilizers, the grape-grower has much to learn and in learning he must approach the problem with humility of mind. For in his experimenting, which is the best way to learn, he will no sooner arrive at what seems to be a certain conclusion, than another season's results or the yields in an adjoining vineyard will upset the findings of past seasons and those obtained in other places. Unfortunately, there is little real knowledge to be obtained on the subject, for grape-growers have not yet broken away from time-worn dictums in regard to fertilizers and still follow recommendations drawn from work with truck and field crops. This is excused by the fact that there have been almost no comprehensive experiments in the country with fertilizers for grapes.

No fallacies die harder than the pronouncements of chemists a generation ago that fertilizing consists in putting in the soil approximately that which the plants take out; and that the chemical composition of the crop affords the necessary guide to fertilizing. These two theories are the basis of nearly every recommendation that can be found for the use of fertilizers in growing crops. The facts applied to the grape, however, are that the average tillable soil contains a hundred or a thousand times more of the chemical constituents of plants than the grape can possibly take from the soil; and many experiments in supplying food to plants show that the chemical composition of the plant is not a safe guide to their fertilizer require-

ments. Later teachings in regard to the use of fertilizers are: That the quantity of mineral food in a soil may be of far less importance than the quantity of water, and that the cultivator should make certain that there is sufficient moisture in his land so that the mineral salts may be readily dissolved and so become available as plant-food; that far too much importance has been attached to putting chemicals in the soil and too little to the physical condition of the soil, whereby the work of bacteria and the solvent action of organic acids may make available plant-food that without these agencies is unavailable.

These brief and simple statements introduce to grape-growers some of the problems with which they must deal in fertilizing grapes, and show what a complex problem of chemistry, physics and biology fertilizing the soil is; how difficult experimental work in this field is; and how cautious workers must be in interpreting results of either experiment or experience. An account of an experiment in fertilizing a vineyard may make even more plain the difficulties in carrying on experiments in fertilizing fruits and the caution that must be observed in drawing conclusions.

An Experiment in Fertilizing Grapes

The New York Agricultural Experiment Station is experimenting with fertilizers for grapes at Fredonia, Chautauqua County, the chief grape region in eastern America. The experiment should be of interest to every grape-grower from several points of view. It not only shows that there are many and difficult problems in fertilizing grapes, but also the results of the use of manure, commercial fertilizers and cover-crops in a particular vineyard; it suggests the fertilizers to be used and the methods of use; and it furnishes a plan for an experiment by grape-growers who want to try such an experiment and

draw their own conclusions. An account of the experiment and the results for the first five years follows: [1]

Tests at Fredonia.

"In the vineyard at Fredonia eleven plats were laid out in a section of the vineyard where inequalities of soil and other conditions were slight or were neutralized. Each plat included three rows (about one-sixth of an acre) and was separated from the adjoining plats by a 'buffer' row not under test. One plat in the center of the section served as a check, and five different fertilizer combinations were used on duplicate plats at either side of the check. Plats 1 and 7 received lime and a complete fertilizer with quick-acting and slow-acting nitrogen; Plats 2 and 8 received the complete fertilizer but no lime; on Plats 3 and 9 potash was omitted from the complete fertilizer combination; Plats 4 and 10 received no phosphorus; Plats 5 and 11, no nitrogen; and Plat 6 was the check. The materials were applied at such rates that they provided for the first year 72 pounds of nitrogen per acre, 25 pounds of phosphorus and 59 pounds of potassium; and for each of the last four years two-thirds as much nitrogen and phosphorus and eight-ninths as much potassium. The lime was applied the first and fourth years in quantity to make a ton to the acre annually. Cover-crops were sown on all plats alike and were plowed under in late April or early May of each year. These differed in successive years, but included no legumes. The crops used were rye, wheat, barley and cowhorn turnips separately and the last two in combination.

"The cultivation differed only in thoroughness from that generally used in the Belt, the aim being to maintain a good dust mulch during the whole growing season. Pruning by the Chautauqua System was done throughout by one man, who pruned solely according to the vigor of the individual

[1] Quoted from Bul. No. 381, N. Y. Agr. Exp. Sta.

vines and left four, two or three, or no fruiting canes as appeared best. The vineyard was thoroughly sprayed, all plats alike.

"Low winter temperatures, affecting immature wood and buds caused by unfavorable weather of the previous season, reduced yields materially during two of the five years, and practically neutralized any anticipated benefit from fertilizers. Following the first of these low-crop years, came a season, 1911, in which favorable conditions, acting upon vines left undiminished in vigor by the light crop of the previous year resulted in heavy and quite uniform yields on all the plats.

"The yields for the five years are shown in Table I; and a summary showing the average gains from each treatment is given in Table II, with the average financial balance after deducting the cost of fertilizer application from the increased returns from the plats receiving them.

TABLE I. — YIELD OF GRAPES (TONS PER ACRE) IN FERTILIZER EXPERIMENTS

Plat. No.		1909	1910	1911	1912	1913	5-year average
		Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1	Complete fertilizer; lime	4.48	2.10	5.37	3.46	2.14	3.51
2	Complete fertilizer . .	4.76	2.21	5.71	4.30	2.83	3.96
3	Nitrogen and phosphorus	5.17	2.14	5.61	4.00	2.25	3.83
4	Nitrogen and potash .	4.25	2.55	5.64	4.10	2.85	3.87
5	Phosphorus and potash	3.41	2.00	5.44	4.35	1.78	3.39
6	Check	3.38	2.10	5.32	3.60	1.24	3.12
7	Complete fertilizer; lime	4.69	2.38	5.62	4.80	3.04	4.10
8	Complete fertilizer . .	4.66	2.07	5.71	4.98	2.72	4.02
9	Nitrogen and phosphorus	4.99	2.04	5.35	4.89	2.61	3.97
10	Nitrogen and potash .	4.79	2.26	5.91	4.89	3.07	4.18
11	Phosphorus and potash	4.99	1.87	5.03	4.21	1.97	3.61

TABLE II. — AVERAGE INCREASE IN GRAPE YIELDS AND AVERAGE FINANCIAL GAIN FROM FERTILIZER APPLICATIONS

N = nitrogen, P = phosphorus, K = potassium, Ca = lime.
Gains in tons per acre.

	N, P, K, Ca.	N, P, K.	N, P.	N, K.	P, K.
	Tons	*Tons*	*Tons*	*Tons*	*Tons*
First plat of pair	3.51	3.96	3.83	3.87	3.39
Second plat of pair	4.10	4.02	3.97	4.18	3.61
Average	3.80	3.97	3.90	4.02	3.50
Check plat	3.12	3.12	3.12	3.12	3.12
Average gain	.68	.85	.78	.90	.38
Average financial gain	$5.82	$13.84	$14.05	$18.54	$6.99

From this last table the benefit from nitrogen appears quite evident since every combination in which it appears gives a substantial gain over the one from which it is absent. Phosphorus and potassium without the nitrogen, lead to only a slight increase over the check; and lime appears to be of no benefit. Financially, the complete fertilizer and lime combination, the nitrogen and phosphorus combination and the phosphorus and potassium combination failed to pay their cost in five of the ten comparisons; the complete fertilizer was used at a loss four times out of ten; and the nitrogen and potassium combination three times out of ten. Lime had no appreciable effect on either vines or fruit.

"No effect of the fertilizers on the fruit itself, aside from yield, was shown for the first three years; but in 1912, and even more markedly in 1913, the fruit from the plats on which nitrogen had been used was superior in compactness of cluster, size of cluster and size of berry. In 1912 also, when early ripening was a decided advantage, the fruit on the nitrogen plats matured earlier than that on the check plats. In 1913 the

favorable ripening season and the smaller crop tended to equalize the time of ripening on all plats. The grapes on the phosphorus-potassium plats were better in quality than those in the check plats but not as good as those on the plats where nitrogen was used.

"Other indexes also show plainly the benefit from nitrogen in this vineyard; for size and weight of leaf, weight of wood produced and number of fruiting canes left on the vines were all greater where fertilizers, and particularly nitrogen, had been used. The three-year averages (1911–1913) of the measurements for these characteristics are shown in Table III:

TABLE III. — COMPARATIVE PRODUCTION OF LEAVES, WOOD AND FRUITING CANES ON GRAPE VINES DIFFERENTLY FERTILIZED

(Averages for three years.)

FERTILIZER APPLICATION	LEAF WEIGHT[1]	WOOD PRUNED[2]	FRUITING CANES LEFT[3]
	Grams.	*Lbs.*	
Complete fertilizer; lime	1,033	1,295	2,468
Complete fertilizer	1,010	1,367	2,609
Nitrogen and phosphorus	1,047	1,272	2,585
Nitrogen and potassium	1,069	1,401	2,646
Phosphorus and potassium	964	1,086	2,326
Check	930	915	2,110

Coöperative experiments.

"In order to secure information as to the behavior of fertilizers on the different soils of the Grape Belt, coöperative tests were carried on in six vineyards owned, respectively, by S. S. Grandin, Westfield; Hon. C. M. Hamilton, State Line; James Lee, Brocton; H. S. Miner, Dunkirk; Miss Frances Jennings, Sil-

[1] Each weight is of 300 green leaves, 5 from each of 60 vines. The first leaf beyond the last cluster was selected.

[2] Amount to the acre of wood pruned in fall.

[3] Number to the acre.

ver Creek; and J. T. Barnes, Prospect Station. The soil in these vineyards included gravelly loam, shale loam and clay loam, all in the Dunkirk series, and the experiments covered from two to two and a half acres in three cases and about five acres in each of the other vineyards. The work continued four years in all but one of the experiments, which it was necessary to end after the second year.

"The general plan of the tests was much like that at Fredonia in most of the vineyards, with the additions of plats for stable manure and for leguminous and non-leguminous cover crops with and without lime. From two to six check plats were left for comparison in each vineyard. As already stated the results were often inconsistent in duplicate plats in the same vineyard, and if one test appeared to point definitely in a certain direction, the indication would be negatived by results in other vineyards. In these experiments the yield of fruit was the only index to the effect of treatments as it was not possible to weigh leaves or pruned wood, or to count the canes left.

"Nitrogen and potassium in combination, which gave the largest gains and greatest profit in the Station vineyard at Fredonia, showed a 13 per ct. increase in yield on one plat in the Jennings vineyard and a 9 per ct. decrease on the other; in the Miner vineyard this combination apparently resulted in a 25 per ct. increase; in the Lee vineyard in a $2\frac{1}{2}$ per ct. loss; in the Hamilton vineyard a 17 per ct. gain; and in the Grandin vineyard neither gain nor loss. In only two of the five vineyards in which this combination was tested was the gain great enough to pay the cost of the fertilizer applied. Similar discrepancies, or absence of profitable gain, mark the use of the other fertilizer combinations.

"Even stable manure, the standby of the farmer and fruit-grower, when applied at the rate of five tons per acre each spring, and plowed in, did not, on the average, pay for itself. Indeed, there were few instances among the 60 comparisons

possible, in which more than a very moderate profit could be credited to manure. The average increase in yield following the application of manure alone was less than a quarter of a ton of grapes to the acre; while the use of lime with the manure increased the gain to one-third of a ton per acre. The ton of lime to the acre annually would not be paid for by the gain of 175 pounds of grapes. Cover-crops were used in five of the six coöperative experiments and proved even less adapted to increasing crop yields than did the manure. There was no appreciable gain, on the average, from the use of mammoth clover; indeed, a slight loss must be recorded for the clover except upon the plats which were also limed, and even with the lime the average yields on check plats and mammoth clover plats differed by only one one-hundredth of a ton. Wheat or barley with cowhorn turnips made a slightly better showing, as the plats on which these crops were turned under, without lime, averaged about one-twentieth of a ton to the acre better than the checks. With these non-legumes, lime was apparently a detriment, as the plants with the lime yielded a tenth of a ton less, on the average, than those without it."

Practical lessons from the Fredonia experiment.

From this experiment it becomes clear that the use of fertilizers in a vineyard is a local problem. General advice is of little value. It is evident also that the fertilization of vineyards is so involved with other factors that only carefully planned and long continued work will give reliable information as to the needs of vines. Indeed, field experiments even in carefully selected vineyards, as the coöperative experiments show, may be so contradictory and misleading as to be worse than useless, if deductions are made from the results of a few seasons. The experiment, however, has brought forth information about fertilizing vineyards that ought to be most helpful to grape-growers. Thus, the results suggest:

Only vineyards in good condition respond to fertilizers.

It is usually waste to make applications of fertilizers in poorly drained vineyards, in such as suffer from winter cold or spring frosts, where insect pests are epidemic and uncontrolled or where good care is lacking. The experiments furnish several examples of inertness, ineffectiveness or failure to produce profit when the fertilizers were applied under any of the conditions named. They emphasize the importance of paying attention to all of the factors on which plant growth is dependent. Moisture, soil temperature, aëration, the texture of the soil, freedom from pests, cold and frosts, as well as the supply of food may limit the yield of grapes.

A vineyard soil may have a one-sided wear.

It is certain in some of the experiments and strongly indicated in others that the soil is having a one-sided wear — that only one or a very few of the elements of fertility are lacking. The element most frequently lacking is nitrogen. Exception will probably be found in very light sands or gravels which are often deficient in potash and the phosphates; or on soils so shallow or of such mechanical texture that the root range of the vine is limited; or in soils so wet or so dry as to limit the root range or prevent biological activities. These exceptions mean, as a rule, that the soils possessing the unfavorable qualities are unfitted for grape-growing. The grape-grower should try to discover which of the fertilizing elements his soil lacks and not waste by using elements not needed.

Grape soils are often uneven.

The marked unevenness of the soil in the seven vineyards in which these experiments were carried on, as indicated by the crops and the effects of the fertilizers, furnishes food for thought to grape-growers. Maximum profits cannot be approached

in vineyards in which the soil is as uneven as in these, which were in every case selected because there was an appearance of uniformity. A problem before grape-growers is to make uniform all conditions in their vineyards, and the vines must be kept free from pests if fertilizers are to be profitably used.

How a grape-grower may know when his vines need fertilizers.

A grape-grower may assume that his vines do not need fertilizers if they are vigorous and making a fair annual growth. When the vineyard is found to be failing in vigor, the first step to be taken is to make sure that the drainage is good; the second step, to control insect and fungous pests; the third, to give tillage and good care; and the fourth step is to apply fertilizers if they be found necessary. Few vineyards will be found to require a complete fertilizer. What the special requirements of a vineyard are can be ascertained only by experiment and are probably not ascertainable by analyses of the soil. This experiment furnishes suggestions as to how the grape-grower may test the value of fertilizers in his own vineyard.

Applying fertilizers.

When it is certain that vines need fertilization, and what is wanted is known, the fertilizers should be put on in the spring and be worked in by the spring cultivation. Stable manure should be plowed under. Grape roots forage throughout the whole top layer of soil so that the land should be covered with the fertilizer, whether chemical or barnyard manure. Applications of commercial fertilizers are generally spread broadcast, though it is better to drill them in if the foliage is out on the vines and thus avoid possible injury to tender foliage. Commercial fertilizers should be mixed thoroughly and in a finely divided state. In leachy soils, nitrate of soda ought not to be applied too early in the season, as it will quickly wash down out of reach of the grape roots.

PLATE VIII. — Brighton ($\times \frac{2}{3}$).

Over-rich soils.

Some soils are too rich for the grape. On these the growth is over-luxuriant, the wood does not mature in the autumn, fruit-buds do not form and the fruit is poor in quality. Certain varieties can stand a richer soil than others. Over-richness is a trouble that may cure itself as the vines come in full bearing and make greater demands on the soil for food. It is well, however, on a soil that is suspected of being too rich or so proved by the behavior of the vines, to provide an extra wire on the trellis, to prune little and thus take care of the rampant growth. Some soils, however, and this is often the case, are so rich that the grape cannot be made to thrive in them; the vines waste their substance in riotous living, producing luxuriant foliage and lusty wood but little or no fruit.

CHAPTER VII

PRUNING THE GRAPE IN EASTERN AMERICA

The inexperienced look on pruning as a difficult operation in grape-growing. But once a few fundamentals are grasped, grape-pruning is not difficult. There is much less perplexity in pruning the grape than in pruning tree-fruits. Pruning follows accepted patterns in every grape region, and when the pattern is learned the difficulties are easily overcome. The inexperienced are confused by the array of "principles," "types," "methods," "systems" and the many technical terms that enter into discussions of grape-pruning. Some of the technicalities come from European practices, and others originated in the infancy of grape-growing in this country when there was great diversity in pruning. Divested of much that is but jargon, an inexperienced man can easily learn in a few lessons, from word of mouth or printed page, how to prune grapes.

The simplicity of pruning has led to slighting the work in commercial vineyards, by too often trusting it to unskilled hands. Then, too, in this age of power-propelled tools, pride in hand labor has been left behind, and few grape-growers now take time and trouble to become expert in pruning. Simple as the work may seem to those long accustomed to it, he who wants to put into his pruning painstaking intelligence and to taste the joy of a task well done finds in this

vineyard operation an ample field for pleasure and for the development of greater profits. The price to be paid by those who would thus attempt perfection in pruning the vine is forward vision, the mechanic's eye, the gardener's touch, patience, and pride in handicraft.

Simple as pruning is, the pruner soon learns that it is an art in which perfection is better known in mind than followed in deed. The theory is easy but there are some stumbling blocks to make its consummation difficult. It is an art in which rules do not suffice, for no two vineyards can be pruned alike in amount or method, and every grape-grower finds his vineyard a proper field for the gratification of his taste in pruning. Happily, however, enlightened theory and sound practice are in perfect accord in grape-pruning, so that specific advice is well founded on governing principles.

One cannot, of course, learn to prune unless he understands the habit of the grape-vine and is familiar with the terms applied to the different parts of the vine. As a preliminary to this chapter, therefore, knowledge of Chapter XVII, in which the structure of the grape-vine is discussed, is necessary. The next step is to distinguish between pruning and training.

Pruning and Training Distinguished

The grape is pruned to increase in various ways the economic value of the plant by increasing the quantity and value of the crop. This is pruning proper. Or grapes are pruned to make well-proportioned plants with the parts so disposed that the vines are to the highest degree manageable in the vineyard. This is training. To repeat, the grape-plant is pruned to regulate the crop; it is trained to regulate the vine. Grape-growers usually speak of both operations as "pruning," but it is better to keep in mind the two conceptions. The distinctions between pruning and training must be made more apparent by

setting forth in greater detail the results attained by the two operations.

Results attained in pruning to regulate the crop.

Proper pruning of vines in their first year in the vineyard, which, as we have seen, consists of cutting the young plants back severely, brings the vines in productive bearing a year or two years earlier than they would have borne had the pruning been neglected. This early pruning, since it is done with an eye to the vigor of each vine, insures greater uniformity in the growth and productiveness of the vineyard. Uniformity thus brought about is important not only for the time being, but for the future development of the vines, since weak vines, if unpruned, are stunted and may require years to overtake more vigorous vines in the vineyard.

The quality of the crop may be regulated by pruning. When vines bear too heavily, the grapes are small, and wine-makers have found that they seldom develop sugar and flavor as do grapes on vines not overbearing. Grapes on vines too heavily laden seldom ripen or color well. Not only are the grapes on poorly pruned and unpruned vines poor in quality but the grapes on such vines are usually not well distributed and therefore ripen and color unevenly. The results just mentioned follow because the bunches in a poorly distributed crop receive varying amounts of light and heat depending on the distance from the ground, the distance from the trunk and on the amount of shade.

Pruning may be used to regulate the quantity of grapes borne in a vineyard and so be made somewhat helpful in preventing alternate bearing. Abnormally large crops are usually followed by partial crop failure and biennial bearing sometimes sets in, but the large crop may be reduced by pruning and the evil consequences wholly or partly avoided. It follows that pruning must depend much on the vigor of the vine;

for a weak vine may be so pruned as to cause it to overbear; and, on the other hand, a vigorous vine pruned in the same way might not bear at all.

Results attained in pruning to regulate the vine.

It is necessary to regulate the shape of the vine by training so that tilling, spraying, pruning and harvesting can be easily performed and the crop be kept off the ground. The cost of production is always less in a well-pruned vineyard because all vineyard operations are more easily carried out.

The life of a vineyard is lengthened when the vines are well trained, because when the parts of a vine are properly disposed on trellis or stake the plants are less often injured in vineyard operations. Moreover, not infrequently vines die from overproduction and consequent breaking of canes or trunks which might have been prevented by pruning to shape the vine. Suckers and water-sprouts are less common on well-trained vines. It is necessary, too, by training to keep the bunches away from trunk, canes and other bunches and so prevent injury to the grapes.

Lastly, fashion, taste or a more or less abnormal use of the grapes, may prescribe the form in which a vine is trained. Fashion and taste run from very simple or natural styles to exceedingly complex, formal ones, depending, often, on the variety, the environment or other condition, but just as often on the whim of the grape-grower. The grape is a favorite ornamental for fences, arbors and to cover buildings; for all of these purposes the vines must be trained as occasion calls.

Some Principles of Pruning

Leaving the shaping of the plant out of consideration and having in mind pruning proper, all efforts in pruning are directed toward two objects: (1) The production of leafy shoots

to increase the vigor of the plant. (2) The promotion of the formation of fruit-buds. The first, in common parlance, is pruning for wood; the second, pruning for fruit.

Pruning for wood.

Some grapes, in common with varieties of all fruits, produce excessive crops of fruit so that the plants exhaust themselves, to their permanent injury and to the detriment of the crop. Something must be done to restore and increase vegetative vigor. The most natural procedure is to lessen the struggle for existence among the parts of the plant. The richer and the more abundant the supply of the food solution, the greater the vegetative activity, the larger the leaves and the larger and stouter the internodes. Obviously, the supply of food solution for each bud may be increased by decreasing the number of buds. The weaker the plants, therefore, the more the vine should be cut. The severe pruning in the first two years of the vine's existence is an example of pruning for wood. The vine is pruned for wood in the resting period between the fall of leaf and the swelling of buds the following spring.

Pruning for fruit.

Growers of all fruits soon learn that excessive vegetative vigor is not usually accompanied by fruitfulness. Too great vigor is indicated by long, leafy, unbranching shoots. Some fruit-growers go so far as to say that fruitfulness is inversely proportionate to vegetative vigor. There are several methods of diminishing the vigor of the vine; as, withholding water and fertilizers, stopping tillage, the method of training and by pruning. Pruning is used to decrease the vigor of the vine, in theory at least, for the practice is not always so successful, by pruning the roots or by summer-pruning the shoots.

Root-pruning the grape at intervals of several years is a regular practice with some varieties in warm countries, Eu-

rope more especially, but is seldom or never practiced in America except when planting and when roots arise from the cion above the union of stock and cion.

Summer-pruning to induce fruitfulness consists in removing new shoots with newly developed leaves. These young shoots have been developed from reserve material stored up the preceding season, and until they are so far developed that they can perform the functions of leaves they are to be counted as parasites. When, therefore, these shoots are pruned or pinched away, the plant is robbed of the material used by the lusty shoot which up to this time has given nothing in return. The vigor of the plant is thus checked and fruitfulness increased. Summer-pruning may become harmful if delayed too long. The time to prune is past with the grape when the leaves have passed from the light green color of new growth to the dark green of mature leaves.

Fruit-bearing may be augmented by bending, twisting or ringing the canes, since all of these operations diminish vegetative vigor. Ringing is the only one of these methods in general use, and this only for some special variety or special purpose, and usually with the result that the vigor of the vine is diminished too much for the good of the plant. Ringing is discussed more fully in Chapter XVI.

The manner of fruit-bearing in the grape.

Before attempting to prune, the pruner must understand precisely how the grape bears its crop. The fruit is borne near the base of the shoots of the current season, and the shoots are borne on the wood of the previous year's growth coming from a dormant bud. Here is manifested one of Nature's energy-saving devices, shoot, leaves, flowers and fruit spring in a short season from a single bud. In the light of this fact, pruning should be looked on as a simple problem to be solved mathematically and not as a puzzle to be untangled, as so many re-

gard it. For an example, a problem in pruning is here stated and solved.

A thrifty grape-vine should yield, let us say, fifteen pounds of grapes, a fair average for the mainstay varieties. Each bunch will weigh from a quarter to a half pound. To produce fifteen pounds on a vine, therefore, will require from thirty to sixty bunches. As each shoot will bear two or three bunches, from fifteen to thirty buds must be left on the canes of the preceding year. These buds are selected in pruning on one or more canes distributed on one or two main stems in such manner as the pruner may choose, but usually in accordance with one or another of several well-developed methods of training. Pruning, then, consists in calculating the number of bunches and buds necessary and removing the remainder. In essence pruning is thinning.

Horizontal versus *perpendicular canes.*

An old dictum of viticulture is that the nearer the growing parts of the vine approach the perpendicular, the more vigorous the parts. The terminal buds, as every grape-grower knows, grow very rapidly and probably absorb, unless checked, more than their share of the energy of the vine. This tendency can be checked somewhat by removing the terminal buds, which also helps to keep the plants within manageable limits, but is better controlled by training the canes to horizontal positions. Grape canes are tied horizontally to wires to make the vines more manageable and to reduce their vigor and so induce fruitfulness; they are trained vertically to increase the vigor of the vine.

Winter-pruning.

Winter-pruning of the vineyard may be done at any time from the dropping of the leaves in the autumn to the swelling of the buds in the spring. The sap begins to circulate actively in the grape early in the spring, even to the extremities of the vine,

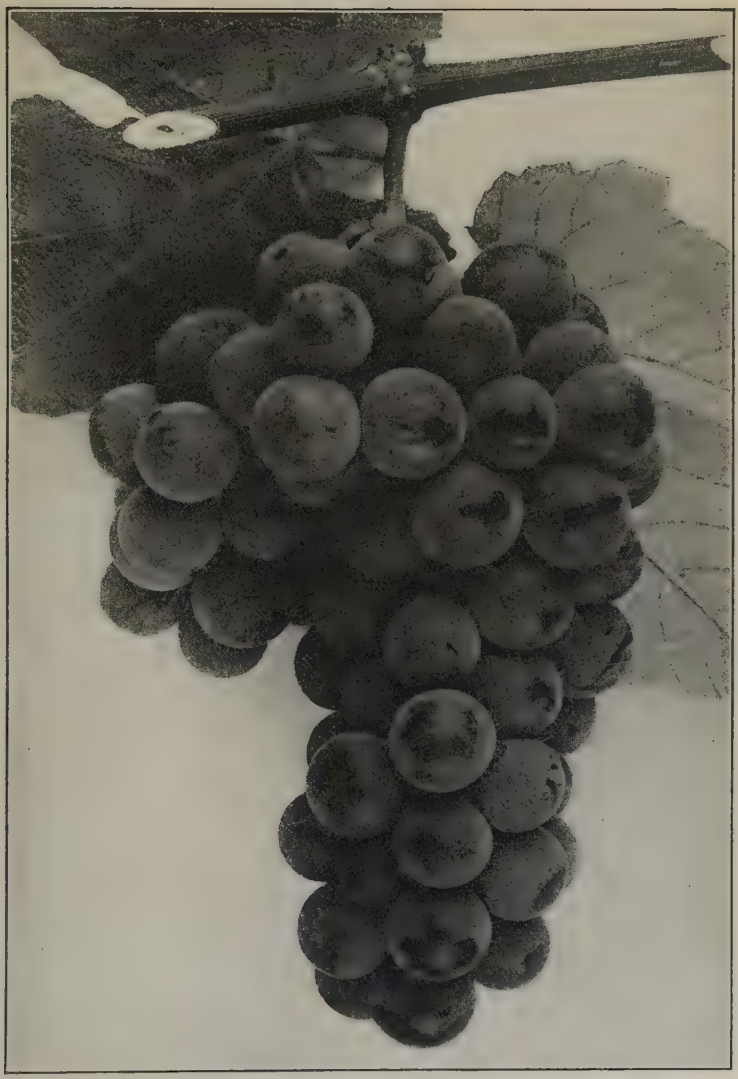


PLATE IX. — Campbell Early ($\times \frac{2}{3}$).

and most grape-growers believe this sap to be a "vital stream" and that, if the vine is pruned during its flow, the plant will bleed to death. The vine, however, is at this season of so dropsical a constitution that the loss of sap is better denominated "weeping" than "bleeding." It is doubtful whether serious injury results from pruning after the sap begins to flow, but it is a safe practice to prune earlier and the work is certainly pleasanter. The vine should not be pruned when the wood is frozen, since at this time the canes are brittle and easily broken in handling. On the other hand, it is well to delay pruning in northern climates until after a heavy freeze in the autumn, to winterkill and wither immature wood so that it can be removed in pruning.

Summer-pruning.

There are three kinds of summer-pruning, the removal of superfluous shoots, heading-in canes to keep the vines in manageable limits and the pruning to induce fruitfulness discussed on a foregoing page, which need not have further consideration. It is very essential that the grower keep these three purposes in mind, especially as there is much dispute as to the necessity of two of these operations.

All agree that the vine usually bears superfluous shoots that should be removed. These are such as spring from small, weak buds or from buds on the arms and trunk of the vine. These shoots are useless, devitalize the vine, and hinder vineyard operations. A good practice is to rub off the buds from which these shoots grow as they are detected, but in most vineyards the vines must be gone over from time to time as the shoots appear. Still another kind of superfluous shoots, which ought to be removed as they appear, are those which grow from the base of the season's shoots, the so-called secondary or axillary shoots. These are usually "broken out" at the time the shoots from weak buds are removed.

While there is doubt as to the value of heading-back the vine in the summer for the sole purpose of inducing fruitfulness, there can be no doubt that it is desirable for the purpose of keeping some varieties within bounds. Heading-back is not now the major operation it once was, the need of severe cutting being obviated by putting the vines farther apart, by training high on three or even four wires and by adopting one of the drooping systems of training. The objections to heading-back in the summer are that it often unduly weakens the vines, that it may induce a growth of laterals which thicken the vines too much, and that it delays the maturing of the wood. These bad effects, however, can be overcome by pruning lightly and doing the work so late in the season that lateral growths will not start. Most vineyardists who keep their plantations up find it necessary to head back more or less, depending on the season and the variety. The work is usually done when the over-luxuriant shoots begin to touch the ground. The shoots are then topped off with a sickle, corn-cutter or similar tool.

Renewing Fruiting Wood

There are two ways of renewing the fruiting wood on a grape-vine, by canes and from spurs. The manner of renewing refers to pruning and not to training, for either can be used in any method of training.

Cane renewals.

Renewal by canes is made each year by taking one or more canes, cut to the desired number of buds, to supply bearing shoots. By this method the most of the bearing wood is removed each year, new canes taking the place of the old. These renewal canes may be taken either from the head of the vine or from the ground, though the latter is little used except where

vines must be laid down for winter protection. Canes may be renewed indefinitely, if care is exercised in keeping the stubs short, without enlarging the head from which the canes are taken out of proportion to the size of the trunk. Renewing by canes is a more common method than renewal by spurs, as will be found in the discussion of methods of training.

Spur renewal.

In renewing by spurs, a permanent arm is established to right and left on the canes. Shoots on this arm are not permitted to remain as canes but are cut back to spurs in the dormant pruning. Two buds are left at this pruning, both of which will produce bearing shoots; the lower one, however, is not suffered to do so but is kept to furnish the spur for the next season. The shoot from the upper bud is cut away entirely. When this process is carried on from year to year, the spurs become longer and longer until they become unwieldy. Occasionally, however, happy chance permits the selection of a shoot on the old wood for a new spur. Failing in this, a new arm must be laid down and the spurring goes on as before. The objections to renewing by spurs are: it is often difficult to replace spurs with new wood, and the bearing portion of the vine gets farther and farther from the trunk. For these reasons, spur-renewing is generally in disfavor with commercial grape-growers, though it is still used

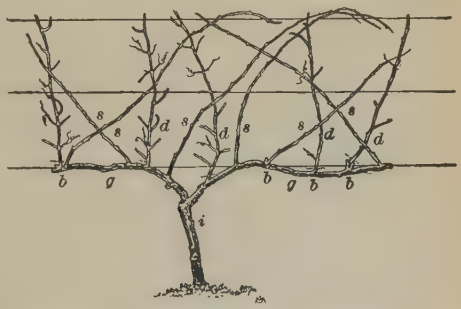


FIG. 13. Vine ready for pruning; *i*, the stem; *g*, arms; *d*, canes; *s*, shoots; *b*, spurs. The faint lines near the bases of the canes indicate the points where they should be pruned off in the winter, leaving spurs for the production of shoots the following season.

in one or two prominent methods of training, as will be discovered in this discussion. Figure 13 shows a vine ready for pruning.

The Work of Pruning

The pruner may take his choice between several styles of hand pruning-shears with which to do his work. The knife is seldom used except in summer-pruning, and here, more often, the shoots are broken out or pinched out. In winter-pruning, the cane is cut an inch or thereabout beyond the last bud it is desired to leave; otherwise the bud may die from the drying out of the cane. The canes are usually allowed to remain tied to the wires until the pruning is done, though growers who use the Kniffin method of training may cut them loose before they prune. Two men working together do the work of pruning best. The more skilled of the two severs the wood from the bearing vine, leaving just the number of buds desired for the next season's crop. The less skilled man cuts tendrils and severs the cut canes from each other so that the prunings may be moved from the vineyard without trouble by the "stripper."

Not the least of the tasks of pruning is "stripping" the brush and getting it out of the vineyard. The prunings cling to the trellis with considerable tenacity and must be pulled loose with a peculiar jerk, learned by practice, and placed on the ground between the rows. Stripping is done, usually by cheap labor, at any time after the pruning until spring, but must not be delayed until growth starts or the young buds may suffer as the cut wood is torn from the trellis. The brush is hauled to the end of the row by hand or by horse-power applied to any one of a dozen devices used in the several grape regions. One of the best is the device in common use in the Chautauqua vineyards of western New York. A pole, twelve feet long, four inches in diameter at the butt and two at the top, is bored with

an inch hole four feet from the butt. A horse is hitched to this pole by a rope drawn through the hole, and the pole, butt to the ground, is then pulled between rows, the small end being held in the right hand. The pole, when skillfully used, collects the brush, which is dumped at the end of the row by letting the small end fly over towards the horse. The "go-devil," shown in Fig. 14, is another common device for collecting prunings.

FIG. 14. A "go-devil" for collecting prunings.

THE TRELLIS

The trellis is a considerable item in the grape-grower's budget, since it must be renewed every fifteen years or thereabouts. Wires are strung in the North at the end of the second season after planting, but in the South the growth is often so great that the wires must be put up at the end of the first season. Trellises are of the same general style for commercial vineyards; namely, two or three wires tautly stretched on firmly set posts. Occasionally slat trellises are put up in gardens but these are not to be recommended for any but ornamental purposes.

Posts.

Strong, durable posts of chestnut, locust, cedar, oak or reënforced cement are placed at such distance apart that two or three vines can be set between each two posts. The distance apart depends on the distance between vines, although the tendency now is to have three vines between two posts. The posts are from six to eight feet in length, the heaviest being used as end posts. In hard stony soils it may be necessary to

set the end posts with a spade, but usually sharpened posts can be driven into holes made with a crow-bar. In driving, the operator stands on a wagon hauled by a horse and uses a ten- or twelve-pound maul. The posts are driven to a depth of eighteen or twenty-four inches for the end posts. However set, the posts must stand firm to hold the load of vines and fruit. The end posts must be braced. As good a brace as any is made

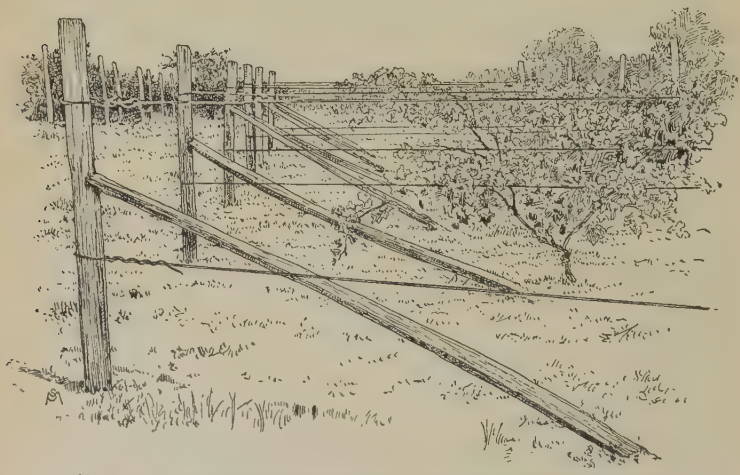


FIG. 15. A trellis and a common method of bracing end posts.

from a four-by-four timber, notched to fit the post halfway up from the ground, and extending obliquely to the ground, where it is held by a four-by-four stake. A two-wire trellis and a common method of bracing end posts are shown in Fig. 15. The posts on hillsides must lean slightly up-hill, otherwise they will almost certainly sooner or later tilt down the slope. The posts are usually permitted to stand a little higher at first than necessary so that they may be driven down should occasion call; driving is usually done in the early spring.

Wire for the trellis.

Four sizes of wire are in common use for vineyard trellises; nos. 9, 10, 11 and 12. Number 9, the heaviest, is often used for the top wire with lighter wires lower. The following figures show the length of wire in a ton:

No. 9, 34,483 ft.	No. 11, 52,352 ft.
No. 10, 41,408 ft.	No. 12, 68,493 ft.

From these figures the number of pounds required to the acre is easily calculated. Common annealed wire makes a durable trellis, but many growers prefer the more durable galvanized wire, the cost of which is slightly greater. The wires are fastened to the end posts by winding once around the post, and then each wire is firmly looped about itself; they are secured to the intervening posts by ordinary fence staples so driven that the wire cannot pull through of its own weight but with space enough to permit tightening from season to season. The size and length of the staples depend on whether the posts are hard or soft wood. The longest and largest staples are used with soft woods, as cedar or chestnut. An acre requires from nine to twelve pounds of staples. The wires should be placed on the windward sides of posts and on the up-hill side in hillside vineyards. The distance between wires depends on the method of pruning.

The wires must be stretched taut on the posts, for which purpose any one of a half-dozen good wire stretchers may be purchased at hardware stores. Some growers loosen the wires after harvest to allow for the contraction in cold weather and others use some one of several devices to relieve the strain. Most growers, however, find it necessary to go over the vineyard each spring to drive down loosened posts and stretch sagging wires, and so take no precautions to release wires in the fall. All agree that the wires must be kept tight during

the growing season to protect buds, foliage and fruit from being injured from whipping.

Tying.

The canes are tied to the trellis in early spring, and under most systems of pruning the growing shoots are tied in the summer. This work is done by cheap men, women, boys and girls. A great variety of material is used to make the tie, as raffia, wooltwine, willow, inner bark of the linden or basswood, green rye straw, corn husks, carpet-rags and wire. The same materials are not usually employed for both canes and shoots, since the canes are tied firmly to hold them steady and the work is done early before there is danger of breaking swelling buds, while the summer shoots are tied to hold for a shorter time and more loosely to permit growth in diameter. Tying usually follows accepted patterns in one region but varies greatly in different regions. There is a knack to be learned in the use of each one of the materials named, but with none is it difficult, and an ingenious person can easily contrive a tie of his own to suit fancy or conditions.

PLATE X. — Clinton ($\times \frac{2}{3}$).

CHAPTER VIII

METHODS OF TRAINING GRAPES IN EASTERN AMERICA

The grape-grower takes great liberties with Nature in training his plants. No other fruit is so completely transformed by the grower's art from its natural habit of growth. Happily, the grape endures cutting well, and the pruner may rest assured that he may work his will in pruning his vines, following to his heart's desire a favorite method with little fear of seriously injuring his vines. Because of its accommodation to the desires of man in the disposition of the vine, there are many methods of training the grape; there being in the commercial vineyards of eastern America a dozen or more. However, the differences and similarities are so marked that the several methods fall into a simple classification which makes conspicuous their chief features. Thus, all of the methods fall under two chief heads: (1) The disposition of shoots; (2) the disposition of canes.

The disposition of shoots.

Bearing shoots are disposed of in three ways in training grapes; shoots upright, shoots drooping, and shoots horizontal. The terms explain themselves, but the three methods need amplification since their adoption is not optional with growers but depends on several circumstances.

Shoots are trained upright in several methods in which two or more arms or canes are laid to right and left, sometimes

horizontally, sometimes obliquely along or across horizontal wires. As the shoots grow upward, they are tied to wires above. The upright methods are supposed to distribute the bearing wood more evenly on the vines and to insure greater uniformity in the fruit. In the upright methods, also, the canes and arms are left nearer the ground, which is thought to be an advantage in small, weak or slow-growing varieties. Delaware, Catawba, Iona and Diana are examples of varieties thought to grow best when trained to one of the upright methods.

In the several methods in which the shoots droop, however the canes may be disposed, the shoots are not tied but are allowed to droop at will. These methods are comparatively new but are being rapidly adopted because of several marked advantages. Usually one less wire can be used in a drooping method than in an upright one; since the shoots are not tied, much labor is saved in summer tying; the ground can be tilled with less danger to the vines; and there is less sun-scalding of the fruit, since the pendant foliage protects the clusters. Grape-growers generally agree that strong-growing varieties like Concord, Niagara, Brighton, Diamond and most of the hybrids between European grapes and native species grow best when the shoots droop.

Shoots are trained horizontally in but one recognized method, the Hudson Horizontal, to be described in detail later. Since this method is all but obsolete, there is still less reason for discussing it here, the expressive name sufficing for present purposes.

Disposition of canes.

There are many recognized methods of disposing of the canes in training the grape. The chief of these are discussed in the pages that follow, their names being set down for the present in the classification that follows.

CLASSIFICATION OF METHODS OF TRAINING THE GRAPE IN EASTERN AMERICA

I. Shoots upright:
   1. Chautauqua Arm.
   2. Keuka High Renewal.
   3. Fan.

II. Shoots drooping:
   1. Single-stem, Four-cane Kniffin.
   2. Two-stem, Four-cane Kniffin.
   3. Umbrella Kniffin.
   4. Y-stem Kniffin.
   5. Munson.

III. Shoots horizontal:
   1. Hudson Horizontal.

I. Shoots upright

Systematic training of the grape in America began toward the middle of the nineteenth century with a method in which the shoots were trained upright from two permanent horizontal arms. These arms are laid to right and left on a low wire and bear more or less permanent spurs, from each of which two shoots are produced each season to bear the crop. The number of spurs left on each arm depends on the vigor of the vine and the space between vines. As the shoots grow upward, they are tied to upper wires, there being three wires on the trellis for this method. This method is now known as the Horizontal Arm Spur. It has a serious fault in its troublesome spurs and has almost entirely given way to a modification called the Chautauqua Arm method, much used in the great Chautauqua grape-belt. As one of the chief methods of training the grape in eastern America, this must be described in detail.

The Chautauqua Arm method.

The trellis for this method has two wires, although occasionally three are used. The lower wire is eighteen or twenty

inches above the ground and the second thirty-four inches above the lower. If three are used, the wires are twenty inches apart. F. E. Gladwin, in charge of the vineyard laboratory of the New York Agricultural Experiment Station at Fredonia, in the heart of the Chautauqua belt, describes this method of training as follows:

"The vines are cut back to two buds at each pruning the first two years. If the vines are vigorous two canes are tied up at the beginning of the third year; if scant, but one is left and this, if the growth is extremely unfavorable, is cut back to two buds. The canes are carried up obliquely to the upper wire when the growth permits and are there firmly tied either with twine or fine wire, the latter being more commonly used. The canes are also loosely tied to the lower wire. The pruning for the fourth year consists in cutting away all but two or three canes and a number of spurs from the arms formed by tying up the two canes the previous year. The vine now consists of two arms, arising from near the ground, with two or three canes of the previous year, and several two-bud spurs at intervals along the arms. As far as possible such canes as have arisen but a short distance above the lower wire are selected. All the old wood projecting beyond the last cane retained on each of the arms is cut away. The arms of the third year are bent down from their oblique position and are tied firmly to the lower wire, to the right and left of the center of the vine. These are now permanent arms. The vine at this time consists of two arms, arising from near the ground, tied to the lower wire to the right and left of the center, and on these are two or three canes, pruned long enough to reach to the middle wire at least, and if possible to the upper. They are tied so that they stand in a vertical or oblique position. Along the arms at intervals of a few inches are spurs, consisting of two buds. If the vineyardist maintains the arms permanently, these spurs furnish the fruiting wood for the succeeding year.

"At the pruning for the fifth year one of the arms is cut away entirely, close to the point of its origin. The remaining arm, reaching from the ground to a point a few inches below the level of the lower wire, now becomes the permanent stem. The vineyardist must now provide for the arm cut away. This is done by the selection of a cane, arising from the remaining arm at a point below the lower wire, either directly,

FIG. 16. Chautauqua training; vine ready to prune.

or from a spur left for the purpose. This is pruned to reach the top wire and is tied obliquely to it. This cane at the next pruning is tied down to the lower wire and becomes the second arm. Then the same selection of canes and spurs is made from it as was made at the previous pruning, and the canes are tied up as before. However, if the grower desires to retain both arms of the preceding year for a few years, canes that have grown from the spurs may be tied up and provision made for the following year through further spurring. If but a single

arm is retained, it is pruned in the same way. Spurs may be obtained from canes that have arisen from dormant buds on the arm, or by spurring in the basal canes of the fruiting wood of the year previous. A combination of both methods of renewal will in the long run work out the better, as the repeated spurring in of the basal canes will result in greatly lengthened spurs that will require frequent cutting out. While the canes that arise directly from dormant buds on wood two years and over are not necessarily the best fruiting ones, they can, however, be utilized for renewal purposes.

"The ideal vine pruned to this system now consists of a stem reaching from sixteen or eighteen inches above the ground level or a few inches below the level of the lower wire. Such a vine is shown in Figure 16. From the head two arms arise, one extending to the right, the other to the left and tied along the lower wire, each arm not extending for more than two feet and a half to either side of the head. From the arms two canes on each are tied vertically or obliquely to the top wire. In addition there are left two or three spurs, growing from the upper side of each arm, located at well-spaced intervals starting close to the head; these may be used for the renewal of the arms. The shoots are not tied.

"One of the chief faults of the Chautauqua Arm method is the tendency of the best matured, and most desirable canes to develop at or near the upper wire, while those lower down are often too short, or so poorly matured as to be unfitted for fruiting purposes. When the wood, bearing the well-developed upper canes, is brought down for arms, a considerable interval of the arm from the head to the point where the canes arise is without fruiting wood. Under such conditions the growth will be again thrown to the extremities. If spurring on the arms has been practiced, this undesirable condition is eliminated. With either type of renewal, spurring should be practiced. The fruit from vines trained by this method reaches its highest

development at or near the level of the upper wire, that on the lower shoots is, as a rule, quite inferior. This comes from the fact that the sap flow is more vigorous at these upper points, resulting in more and healthier leaves, which, in turn, influence the fruit for the better."

Keuka High Renewal.

Several methods of training pass under the general term "High Renewal," the significance of which becomes apparent in the discussion of the Keuka High Renewal method which is probably now the most common of the several types. In most of these methods the trellis is put up with three wires, but occasionally only two wires are used and still less often four. The lowest wire on the three-wire trellis is eighteen or twenty inches from the ground with twenty-inch intervals between wires. Gladwin, who has direct charge of vineyard experimental work about Keuka Lake for the New York Agricultural Experiment Station, describes current practices in pruning according to this method as follows:

"At each pruning for the first two years the vines are cut back to two buds. However, with strong-growing varieties like Concord, Niagara and Isabella, and under good soil conditions, the stem may be formed the second year. With moderate-growing varieties and under average conditions, the formation of the stem is left until the third year. The straightest and best-matured cane is left for the purpose. This is carried to the lower wire and there firmly tied with willow. As soon as the shoots have made sufficient growth they are loosely tied to the wires that they may be kept away from the tillage tools. The fourth year the head of the vine is formed. This should stand a few inches below the lower wire. Two canes growing from the stem near this position are selected, one being tied to the right and the other to the left along the lower wire. In the Keuka Lake District, the canes are tied with willows.

In addition, at least two spurs of two buds each are retained near the head. With Concord, the canes may carry about ten buds each, but with Catawba, as grown on the hillsides of the Central Lakes Region of New York, the canes should not carry above six buds each. As the shoots develop from the horizontal canes, they are tied with rye straw to the middle and upper wires. This summer tying is almost continuous after the shoots are long enough to reach the middle wire.

"The following year all the wood is cut away except two or three canes that have developed from the basal buds of the canes put up the previous year, or that have grown from the spurs. In the event of a third cane being retained, it is tied along the middle wire. Spurs are again maintained close to the head for renewal purposes. The other two canes are tied along the lower wire as before. If the same spurs are used for a few years they become so long that the canes arising from them reach above the wire and cannot be well managed in the 'willowing.' It is desirable to provide new spurs annually, selecting those canes for the purpose that arise from the head of the vine or near it. It is possible by careful pruning to so cut away the old wood that practically all that remains after each pruning is the stem. Thus the vine is renewed almost to the ground. When the stem approaches the end of its usefulness, a shoot is allowed to grow from the ground, and the old one is cut away. Figure 17 shows a vine pruned by the Keuka method.

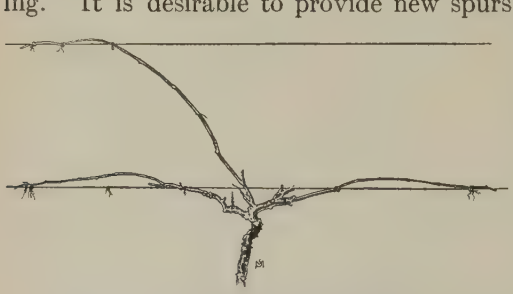


FIG. 17. Keuka method of training.

"This method of training is especially well adapted to slow

growing varieties, or those situated on poor soils, where but little wood growth is made. It is ideally adapted for the growing of Catawba on the hillsides of Keuka Lake. It is well adapted to late-maturing varieties planted out of their zone. Concord, growing under average conditions, is too vigorous to be trained by this method. It makes a tremendous growth of wood out of all proportion to the quantity of fruit, which is inclined to be very inferior. The chief objection to this method is the amount of summer tying involved which comes at a time when attention to tillage should be given. It might prove profitable in the growing of dessert varieties that have been discarded because of lack of vigor. On thin hillside soils, Catawba requires training modelled after this method but on the heavier upland ones, with shorter pruning, it can be grown on the Chautauqua Arm plan. Delaware, Iona, Dutchess, Campbell, Eumelan, Jessica, Vergennes and Regal are, as a rule, grown to better advantage when trained by the High Renewal method."

Fan-training.

The only other method now in use in which the shoots may be trained upright is that in which the canes are disposed of in fan-shape. This method was much used a generation ago but is rapidly becoming obsolete. In fan-training the renewals are made yearly from spurs near the ground, and the fruiting canes are carried up obliquely and so form a fan. The great advantage in fan-training is that a trunk is almost dispensed with, which greatly facilitates laying down the vine in winter where winter-protection is needed. There are several objections to this method in commercial plantations. The chief one is that the spurs become long, crooked and almost unmanageable so that renewals from the root must be made frequently. Another is that the fruit is borne close to the ground and becomes soiled with mud in dashing rains. The vines,

also, are inconvenient in shape for tying. There are two or three modifications of fan-training which may be described as mongrel methods between this and the High Renewal and Horizontal Arm methods, none of which, however, is now in general favor.

II. Shoots drooping

Quite by accident, William Kniffin, a stone mason living at Clintondale, New York, in the Hudson River grape region, discovered that grapes of large size and handsome appearance could be grown on vines in which the canes were trained horizontally with the shoots drooping. He put his discovery in practice and from it have come the several methods of training grapes which bear his name. Kniffin's discovery was made about 1850 and the merits of his methods spread so rapidly over eastern America that by the end of the century the various Kniffin methods were more generally used than any others. Grape-growers now agree that strong-growing vines like Concord, Niagara and Clinton are best trained to one or another of the Kniffin methods. There are several modifications of Kniffin's method, three of which are now in common use, the most popular being the Single-stem, Four-cane Kniffin.

The trellis for the three methods carries two wires, the lower placed at the height of three to three and a half feet and the upper from two to two and a half feet above it. To permit this height of wires, the posts must be from eight to eight and a half feet in length, and must be firmly set with the end posts well braced.

Single-stem, Four-cane Kniffin.

As practiced at the New York Agricultural Experiment Station, the vines are trained as follows:

One trunk is carried to the top wire the third year after planting, or if the growth is not long enough at this time, it

is carried to the lower wire and there tied. In this case, the following year a cane is extended to the top wire. This trunk is permanent. If the stem reaches the upper wire the third year, growers break out many of the developing shoots and allow only the strongest to grow, choosing those that arise close to the wires. The stem should be tied tightly to the top wire and somewhat loosely to the lower. If girdling results at the top, it is not objectionable as the head of the vine should be below rather than above the wire. When the shoots are sufficiently hardened, those growing close to the wires should be loosely tied to prevent injury during cultivation. At the beginning of the fourth year, as shown in Fig. 18, the vine should consist of a stem extending from the ground to a point below the top wire. From this, all but two canes and two spurs of two buds each have been cut away below each wire level. As growth is most vigorous at the top of the stem, four to six more buds are left on the upper than on the lower canes. A vine of which the stem reaches the upper wire the third year should support the next season canes, aggregating twenty-two buds with eight additional buds on the spurs. If the growth is weak, only half this number should be left.

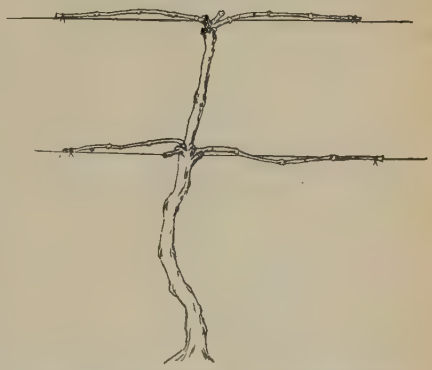


FIG. 18. Single-stem, Four-cane Kniffin training.

The tying at this time consists of fastening the stem loosely, with ordinary grape twine, to the lower wire, and with the same material the canes are tied along the two wires to right and left of the stem. The canes should be tied tightly toward

the trunk so that they cannot slip out of the twine. Ordinarily tying at this time is sufficient for the year, but if conditions for growth are unfavorable, the twine may rot before the tendrils take hold of the wires, and a partial second tying may be necessary.

After the fourth season, the pruner has greater choice of fruiting-wood for the following year. It may be chosen from the basal canes of the preceding year's wood or the canes that develop from the spurs may be used. The choice should depend on the accessibility and maturity of the wood. At each pruning, the possibilities for obtaining fruiting wood for the following year must receive consideration. It is possible to use the same spurs for two or three years, but after this they should be cut away and new ones retained. After the first spurring, spurs should be selected from wood older than two years. The shoots from such wood bear but little fruit and hence make good fruiting canes for the next year.

Umbrella Kniffin.

Since most of the fruit on vines trained by the Four-cane Kniffin method is borne on the two upper canes, some growers in the Hudson River Valley dispense with the lower canes and cut the upper ones long enough to bear the crop. In this method the trunk is brought to the top wire and the head formed as in the Four-cane Kniffin. When the vines are pruned at the close of the third year, two long canes are left at the head of the vine with two renewal spurs.

FIG. 19. Umbrella method of training.

These long canes are drooped over the upper wire obliquely down to the lower wire to which they are tied just above the last bud, forming an unbrella-shaped top as shown in Fig. 19. The renewals are made as in the Four-cane Kniffin. This method reduces the amount of leaf surface to the minimum, so that care must be taken to insure healthy leaf growth. The amount of fruiting-wood put up is also reduced to the minimum, so that the yield is low unless good cultivation is provided, in which case, with some varieties and on some soils, the yield is up to the average and the crop is first-class as regards size of bunch and berry, compactness of bunch and maturity.

The Two-trunk Kniffin.

The Two-trunk Kniffin, illustrated in Fig. 20, is another modification with the aim of securing greater fruitfulness. This method also provides an equal number of buds on both wires. Two trunks are brought from the root, one to the upper, the other to the lower wire. The fruiting canes are taken off and are disposed of as in the Four-cane Kniffin. The trunks are usually tied together to hold them in place. This method is in restricted use in the Hudson River Valley where it is known under the name given here and as "Double Kniffin" and "Improved Kniffin." In experiments in training grapes at Fredonia, New York, under the direction of the New York Experiment Station, this method proves to be one of the poorest in growing Concords. The grapes fall short in size of

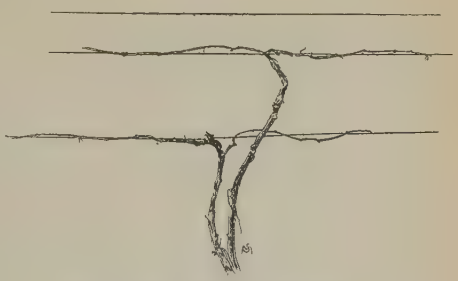


FIG. 20. Two-trunk Kniffin training.

bunch and berry and do not mature as well as under the other drooping methods of training.

The Y-trunk Kniffin.

Still another modification of the Kniffin method is one in which a crotch or Y is made in the trunk midway between the ground and the lower wire. The theory on which this method is founded is that sap for the lower canes is better supplied than in a straight or continuous trunk and that the lower canes thus become as productive as those on the upper wire. The theory is probably wrong but is accepted by many notwithstanding. The methods of pruning, renewing fruiting-wood and tying are the same as in the Single-stem Kniffin, except, of course, that each stem supports two canes and two spurs. This method was in somewhat common use some years ago in parts of western New York but is now disappearing.

The Munson method.

An ingenious modification of the Kniffin principle was devised by Elbert Wakeman, Oyster Bay, Long Island, and afterwards improved and brought into prominence by the late T. V. Munson of Denison, Texas; it is now much used in southern vineyards. The method is described as follows by Munson:[1]

"The posts should be of some durable strong wood, such as Bois d'Arc (Osage), Cedar, heartwood of Catalpa, Black Locust or White Oak. The end posts of every row should be large and strong and be set three and one-half or four feet in the ground and well tamped. The intermediate posts, which may be much lighter than the end posts, should be six and one-half or seven feet long and set two to two and one-half feet in the ground, with twenty-four feet spaces between

[1] Munson, T. V. *Foundations of American Grape Culture:* 224–227. 1909.

posts, which will take three vines, eight feet apart, or two vines twelve feet apart. After the posts are set, a three-eighths-inch hole should be bored through each post, four feet from the surface of the ground, in the direction in which the row runs, leaving six inches or more of post above the hole. These holes are for the admittance of the middle, lower wire of the trellis.

"For each end post prepare for cross-arm, a piece of two by four hard pine or oak, two feet long, and at one inch from either end, and one inch from the upper side, bore a three-eighths of an inch bit-hole, or saw into upper side half an inch, which will take less time and do as well, to pass the lateral wires through, and in the middle of the lower side, saw a notch one-half inch deep. For each intermediate post, prepare a board of similar wood, two feet long, one inch thick by four broad, and likewise bore or notch.

"Through the holes in the posts run a No. 11 galvanized wire, fasten at one end, tighten at the other end by a wire stretcher and fasten. This will be the middle and lower wire of the trellis, and all that will be needed the first year, when the young vines are trained up a string, tied from the vine (when set) to the wire, and along it. The arms, and the two lateral wires which they bear, need not be put on the trellis until after the vines are pruned and tied the next winter. To put on the cross-arms, use no bolts or nails, only No. 11 galvanized wire.

"Each end cross-arm is placed inside the post, and against it on top of the wire, already through the posts, notch-side downward, straddling the wire, to keep it from sliding. Then take a piece of same size wire, about seven feet long, pass one end through the bit-hole or saw-notch, in one end of arm and fasten it by looping and twisting about six inches of the end back upon itself, then while one person holds the cross-arm in place, the operator carries the wire down around the post

once near the ground, staples it on each side and brings the other end up to the opposite end of arm, puts it through the bit-hole, or saw-notch, draws it tightly, keeping the arm level, and fastens the end of the wire as was done the other. Wire nippers and pliers will be needed for this work. Then take another piece of wire about two feet long, and put it twice around the cross-arm and the post where they come together, above the middle wire, and firmly tie them together, crossing the wire as it goes around. This will hold the arm in place and not weaken or split the arm as do nails and bolts, and will be longer-lasting, quicker and cheaper, and more elastic, so that when struck by the hames or collar in cultivation, it gives a little, receiving no damage.

"Likewise place the cross-arms on the intermediate posts, leaving the ends of the wire projecting about six inches after fastening, for a purpose soon to be mentioned. Then draw the two lateral wires through the bit-holes in the ends of the arms, or drop into the saw-notches, if such are made, throughout the row, tighten with the wire stretcher and fasten. Then return along each lateral wire, wrapping ends of wire at the ends of the arms very closely and tightly around the through-going lateral wires, as telegraph and telephone wires are wrapped in splicing. This is quickly done with the proper pliers, and prevents the arms from slipping out of proper position. Now the trellis is complete, and will need little or no repairs, and looks very neat, especially if painted.

"Pruning and training on the Munson trellis is very simple and easy with a little instruction for a few minutes with a vine or two pruned for example. The vine the first season is allowed to grow up on to the middle wire by a string around which it is coiled by hand, by going over the vineyard once or twice until the selected shoot of each vine is upon the wire, after which it is allowed to ramble at freedom over the wires. By getting on to the trellis the first year, one strong shoot,

PLATE XI. — Concord ($\times \frac{2}{3}$).

and allowing no other to grow, a partial crop can be had the second year, without damage, on all but weak growers, like Delaware, that should not be allowed to bear until the third year. At the first regular pruning (all prunings should be done in November or December, after leaf fall, and never so late as to cause the vines to bleed), the vine should be cut back to two or three buds that have reached the middle wire, if weak growers, if strong, with heavy growth, six or eight buds each, to two arms, one going each way along the lower wire from where the ascending vine first touches the wire. After the vines are thus pruned, the outer end of each arm is firmly tied to the lower wire, along which it is gently coiled. These two ties hold the vine firmly in place. The buds on the arms push and ascend, passing over the lateral wires, clinging thereto with their tendrils, and hang over like a beautiful green drapery shading the fruit and body of the vine according to its natural habit.

"On the canopy trellis, all the summer pruning required is, to go through the vineyard at or a few days before blooming time, and with a light sharp butcher knife, clip off the tips of all advanced shoots to be left for bearing, leaving two or three leaves beyond the outer flower cluster. From the shoots near the crotch, selected for bearing arms the next year, pick the flower clusters, and strip off or rub off all shoots and buds that start on trunk of vine below crotch. This latter is very important, as such shoots, if left, eat up the nourishment of the land with no return but added work at pruning time.

"It will be found that the shoots at the ends of the arms usually start first and strongest, and if not clipped back, will not allow the buds back toward the crotch to start well, but if clipped, all other desirable buds then push.

"In about six to ten days after the first clipping, a second one is usually necessary, especially if the weather is moist and warm, and the land rich. The first clipped shoots, as well as

those not clipped the first time, will need clipping back this time, the end buds on the first clipped having pushed vigorously.

"At a second year's pruning and others following, the old arms with all the bearing shoots on them are cut off down to the new arms and the new arms cut back to lengths they can fill with fruit and well mature. In this, critical judgment and knowledge of capabilities of different varieties are more required in the pruner than in any other of the training work. Some varieties, such as the Delaware, cannot carry more than three to four arms, two feet long, while Herbemont can more easily carry four arms each eight feet long, hence such as Delaware should be planted eight feet or less apart, while Herbemont and most of the Post-Oak grape hybrids, should be twelve to sixteen feet apart. In other words, each variety should be set that distance apart that it will fill the trellis with fruit from end to end, and mature it well, so as to better economize space.

"By the third year, the vine should come to full bearing, and be pruned with four bearing arms, two to go each way along the lower wire of trellis, gently coiling around the wire, one arm in one direction, the other in opposite direction, and should be in about equal lengths, so that one firm tie with jute yarn, near the ends, will be all the tying the vines will need — that is, two ties to each vine — the least required by any trellis system, and the pruning is also simplest and the results every way the best.

"Some of the advantages of this trellis are its cheapness, its simplicity, bringing the work up breast-high so that pruning, tying, harvesting, spraying, can be done in an erect position, saving back strain; perfect distribution of light, heat and air to foliage and fruit; shielding from sunscald and birds; giving free ventilation and easy passage of wind through the vineyard without blowing down the trellis or tender shoots from the vines, and allowing ready passage from row to row,

without going around, thus getting larger and better crops at less expense and increasing length of life of vineyard and the pleasure of taking care of it."

This method does not seem to be adapted to the needs of grapes in northern vineyards, and in the South such weak-growing sorts as Delaware do not thrive when so trained. Several "modified Munson methods" are in use in the southern states, but those most commonly employed do not depart greatly from the method here described.

III. Shoots horizontal

Hudson horizontal.

There is now in use but one method of training shoots horizontally. In this method the trellis is made by setting posts eight or ten feet apart and connecting them by two slats, one at the top of the posts, the other about eighteen inches from the ground. Strands of wire are stretched perpendicularly between the slats at ten- or twelve-inch intervals. One cane is trained from a trunk from one to two feet high on the trellis; it rises perpendicularly from the ground and is tied to the top slat. The shoots push out right and left and are tied horizontally to each wire as they reach it. The cane is usually allowed to bear about six shoots on each side. The grapes set at the base of the shoots so that the bunches hang one over the other, making a pretty sight. This method is too expensive for a commercial vineyard but is often used in gardens and for ornamental plantings. Only weak-growing sorts, as Delaware, Iona or Diana are adapted for this method. Delaware does remarkably well under horizontal training. The use of slats and wires in horizontal training are often reversed. The alternative from the method just described is to set posts sixteen or eighteen feet apart upon which are strung two wires as for the ordinary trellis. Perpendicular

slats are then fastened to these wires to which the shoots are tied. Two slats, fifteen inches apart, are provided on each side of a fruiting cane, which, with the slat for the support of the cane, give five to a vine. Or the vine may be supported by a stake driven in the ground.

In both of these methods, a shoot must be taken out from the head of the vine each season for the next season's fruiting-wood. This shoot is tied to the central wire or slat and is now allowed to fruit. Thus the vine starts each spring with a single cane. Grapes are grown under these horizontal methods chiefly, if not only, in the Hudson River Valley and even here they are going out of use.

Training on Arbors, Pergolas and as Ornamentals

The grape is much used to cover arbors, pergolas, lattices and to screen the sides of buildings, few climbing plants being more ornamental. Leaf, fruit and vine have been favorite subjects for reproduction by ornamentalists of all ages. As yet, however, it is seldom seen in cultivated landscapes except to secure shade and seclusion.

Grown for æsthetic purposes, the grape is seldom fruitful, for the vines can rarely be cultivated or deprived of their luxuriant growth as in the vineyard. Nevertheless, grapes grown as ornamentals can be trained so as to serve the double purpose of ornamental and fruit-bearing plant. Grown on the sides of a building, the grape often can be made to bear large crops of choicely fine fruit. The ancients had learned this, for the Psalmist says: "Thy wife shall be like the fruitful vine by the sides of thine house."

In all ornamental plantings on arbors or pergolas, if fruit is to be considered, the permanent trunk is carried to the top of the structure. Along this trunk, at intervals of eighteen inches, spurs are left from which to renew the wood from year to year.

The vines should stand six or eight feet apart, depending on the variety, and one cane is left, three or four feet long, on each spur when the pruning is done. Shoots springing from these cover intermediate spaces soon after growth begins. Provision, of course, must be made for a new cane each season, and this is done by saving a shoot springing from spur or trunk at pruning time.

The same method of training, with modifications to suit the case, may be employed on sides of buildings, walls, fences and lattices. If the object to be covered is low, however, and especially if fruit as well as a covering is wanted, perhaps a better plan is annually to renew from a low trunk or even back to the root. In this low renewal, a new cane, or two or three if desired, should be brought out each season, thus securing greater vigor for the vine, but greatly delaying, especially in the case of high walls, the production of a screen of foliage.

Pruning and Training Muscadine Grapes

The Muscadine grapes of the South are so distinct in characters of growth and fruit-bearing that their requirements as to pruning and training are quite different from the methods so far given. Until recent years when these grapes have become of commercial importance, it was thought by southern vineyardists that the Muscadines needed little or no pruning and some held that pruning injured the vines. Now it is found that Muscadines respond quite as readily as other types of grapes to pruning and training. Husmann and Dearing [1] give following directions for pruning Muscadines:

"Two systems of training are employed with Muscadine grapes: (1) The horizontal or overhead system, by which the growth is spread as an overhead canopy about 7 feet above the

[1] Husmann, George C., and Dearing, Charles. *Muscadine Grapes. Bul. 709, U. S. Dept. Agr.:* 16–19. 1916.

ground and supported by posts; and (2) the upright or vertical system, in which the growth is spread over a trellis.

"In the overhead system a single trunk is caused to grow erect from the ground alongside a permanent post. When the vine has reached the top of the post it is pinched in or cut back, so as to make it throw out shoots to grow and spread out from the head of the vine as the spokes of a wheel radiate from

FIG. 21. Rotundifolia vines trained by the overhead method.

the hub. (The overhead training of Muscadines is shown in Fig. 21; upright training, in Fig. 22.)

"In the upright systems the fruiting arms are either radiated from a low vine head, like the ribs of a fan, or they are taken off as horizontal arms from a central vertical trunk.

"Where the vineyard is not given close personal attention and pruning and other vineyard practices are neglected the best results will be obtained with the overhead trellis. Moreover, such a trellis permits cross-plowing and cultivation and

is better adapted for grazing hogs, sheep, or cattle on cover crops grown in the vineyard. On the other hand, the careful vineyardist can expect the best and earliest results from vines on the upright or vertical supports. The upright trellis facilitates pruning, harvesting, spraying, and intercropping throughout the life of the vineyard; it is also easier to repair and

FIG. 22. A Rotundifolia vine trained by the 6-arm renewal method.

can be erected from $10 to $20 an acre cheaper than the overhead trellis. The use of both the upright system and the overhead trellis has netted the growers profitable returns. Each has its advantages and disadvantages. The prospective grower, knowing his own conditions, must determine which training system is best suited to his conditions.

"During the first year after planting, a strong stake reaching 4 feet above the ground at each vine is sufficient support.

A trellis should be erected the second season, though the upper wires of an upright trellis and the secondary wires of an overhead trellis may be added later, as the vines need them. In erecting an upright trellis the posts should be set midway between the vines, the distances apart varying with the distances between the plants. The end posts of the rows should be firmly braced. Three wires are generally used, placed 24, 42, and from 56 to 60 inches from the ground.

"In erecting an overhead trellis, the usual method is to place a substantial, durable post reaching 7 feet above the ground at each of the permanent vines. Rows of extra heavy, well-braced posts, running parallel with and also at the ends of the rows of vines, are set at the boundaries of the vineyard. There are a number of different ways of arranging the wires. Usually No. 10 galvanized wires are securely fastened to the tops of the boundary posts on the four sides of a vineyard and then are run along and securely fastened on the tops of the inside post down each row in both directions as governor wires. As needed, No. 14 wires 2 feet apart are run parallel with the governor wires until in this manner the entire area has been covered.

"A cheaper but less durable overhead trellis is made by running No. 9 governor wires in only one direction and the secondary wires only at right angles to the governor wires, the secondary wires being fastened to the governor wires wherever they cross.

"Some growers construct arbors entirely of wood, using slats or poles instead of wires.

"The pruning of Muscadine grapes during the first three years is mainly for the purpose of establishing the permanent parts and adjusting the other parts of the vine to the desired training system for future usefulness. After that the pruning is primarily a matter of renewing the bearing surface and keeping the vines healthy, vigorous, and productive.

"During the first season the trunk of the vine should be established. From this the main fruiting branches are started the second season. These, under favorable circumstances, will bear a small crop of fruit the third season. After that the purpose of pruning should be to renew growth, to increase or decrease the bearing surface, and to maintain the shape of the vine.

"Severe pruning usually removes most of the fruit-bearing wood and throws the vine into vigorous wood growth. No pruning, on the other hand, causes a growth which is too much distributed, weak, and incapable of bearing good crops. Therefore, the grape grower should study the vines sufficiently to enable him to judge each year the proper severity of pruning for the best results. This will depend on the variety, the age of the vines, the fertility of the soil, etc. Muscadine grapes bear their fruit in small clusters. It is therefore necessary to maintain a large fruiting surface in order to secure a proper tonnage of fruit. This is accomplished by developing a series of fruiting arms, spurring along these, and lengthening them as the vines become stronger. Such fruiting arms can be maintained for a number of years, but after a time it is desirable to renew them. This is done by cutting out the arm and starting a new one from a cane that has been previously grown for such purposes. It is preferable to renew systematically only one or, at most, two arms on a vine each year. This gradual renewal does not disturb the vigor of the vine, but keeps it productive, healthy, and strong. The pruning can be quickly and easily done if systematically practiced from the time the vines are started."

Rejuvenating Old Vines

When pruning and training are neglected, a vineyard soon becomes a sorry company of halt and maimed vines. These

neglected vines can rarely be reshaped and restored to their pristine vigor. If the old vines seem capable of throwing out a strong new growth, it is almost always better to grow a new top by taking out canes from the roots and so rejuvenate. The energy and activity of Nature are seldom seen to better advantage than in these new tops, if the old tops are cut back severely and the vineyard given good care. The new canes grow with the gusto of the biblical bay tree, making it difficult oftentimes to keep them within bounds.

Usually this new top can be treated essentially as if it were a new vine. Not infrequently the cane will make sufficient growth and mature well enough so that it may be left as a permanent trunk at the end of the first season. If, however, the wood is short, weak and soft, it should be cut back in the autumn to two or three buds from one of which a permanent trunk can be trained the next season from which a good top can be formed in another season. The old top is discarded as soon as the new trunk is tied to the trellis. Old vineyards are often rejuvenated in this way to advantage and return profits to their owners for years; but if the soil is poor and the vines weak, attempts to renew the tops seldom pay.

Occasionally rejuvenating old vines by pruning is worth while. When such an attempt is made, it is best to cut back severely at the winter-pruning, leaving two, three or four canes, depending on the method of training, of six, eight or ten buds. The amount of wood left must depend on the vigor of the plant and the variety. The success of such rejuvenation depends much on selecting suitable places on the old vine from which to renew the bearing wood. It requires good judgment, considerable skill and much experience to rejuvenate successfully an old vineyard by remodeling the existing top, and if the vines are far gone with neglect it is seldom worth while.

Sometimes old vines or even a whole vineyard can be rejuvenated most easily by grafting. This is particularly true

PLATE XII. — Diana ($\times\frac{3}{5}$).

when the vines are not of the kind wanted, and when the vineyard contains an occasional stray vine from the variety to which it is planted. Directions for grafting are given on pages 45 to 50. The grafted vine is readily brought into shape, under any of the several methods of training, by treating it as a young vine.

CHAPTER IX

GRAPE-PRUNING ON THE PACIFIC SLOPE

THE methods of pruning and training native grapes, discussed in the last two chapters, do not apply to the Vinifera grapes grown in the favored valleys of the Rocky Mountains and on the Pacific slope. As we have already seen, the Vinifera or Old World grape differs markedly in habits of growth from the American species so that it would not be expected that pruning which applies to the one would apply to the other types. The fundamentals, to be sure, are much the same and the different species of grapes are about equally subservient to the shears of the pruner, but while pruning to regulate fruit-bearing finds many similarities in Old and New World grapes, the training of the vines is radically different.

European practices in pruning and training Vinifera grapes are so many and so diverse that the first growers of this fruit in America were at a loss to know how to prune their vines. But, out of a half century of experience, American growers of Old World grapes have adapted from European practices and have devised to meet new conditions, methods which serve very well in the new home for this old grape. Since the culture of the Old World grape is centered in California, almost confined to that state, California practice may be taken as a pattern in pruning and training the vines of this species.

Vine Pruning in California [1]

The systems of pruning in use in California may be divided into two classes according to the arrangement of the arms on the trunk of the vine. In the commonest systems, there is a definite head to the trunk, from which all the arms arise symmetrically at nearly the same level. The vines of these systems may be called "headed vines." In the other systems, the trunk is elongated four to eight feet and the arms are distributed regularly along the whole or the greater portion of its length. The vines of these systems, owing to the rope-like form of the trunks, are called "cordons."

The headed vines are divided according to the length of the vertical trunk into high, 2–3 feet, medium, 1–1½ feet, and low, 0–6 inches. The cordons may be vertical or horizontal, according to the direction of the trunk, which is from four to eight feet long. The horizontal cordons may be single (unilateral) or composed of two branches extending in opposite directions (bilateral). Double and even multiple vertical cordons occur, but they are very inadvisable and have no advantages.

The arrangement of the arms of a headed vine may be symmetrical in all directions at an angle of about 45 degrees. Such a vine is said to be "vase-formed," though the hollow center which this term implies is not essential. This is the form used in the great majority of our vineyards whether of wine, raisin, or shipping grapes. It is suitable for the "square" system of planting and cross cultivation. Where vines are planted in the avenue system, particularly when trellised and where cross cultivation is impossible, the arms are given a "fan-shaped"

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arrangement in a vertical plane. This arrangement is considered to be essential for the economical and easy working of trellised vines.

On the vertical or upright cordon, the arms are arranged at as regular intervals as possible on all sides of the trunk from the top to within twelve or fifteen inches of the bottom. On the horizontal cordon the arms are arranged similarly, but as nearly as possible on the upper side of the trunk only.

Each of these systems may again be divided into two subsystems, according to the management of the annual growth or canes. In one, spurs of one, two, or three eyes are left for fruit production. This system is called short or spur pruning. In the other, long canes are left for fruit production. This is called long or cane pruning. In rare cases an intermediate form is adopted in which long spurs or short canes of five or six eyes are left. In cane pruning, each fruit cane is accompanied by one or two short renewal spurs. These must also accompany half-long pruning. Systems of pruning, when only long canes are left without renewal-spurs, are not in use in California. In all systems, replacing-spurs are left wherever and whenever needed.

Other modifications are introduced by the manner of disposal of the fruit canes. These may be tied up vertically to a stake driven at the foot of each vine or bowed in a circle and tied to this same stake, or they may be tied laterally to wires stretching along the rows in a horizontal, ascending or descending direction.

The different systems differ therefore in: (1) the shape, length, and direction of the trunk; (2) the arrangement of the arms; (3) the use of fruit spurs or fruit canes with renewal spurs; (4) the disposal of the fruit canes.

The principal possibilities of the pruning are shown in the following table:

A. Head Pruning: Vase-form

1. High trunk: 2. Medium trunk: 3. Low trunk:	with	(*a*) Fruit spurs or (*b*) Half-long canes and renewal spurs or (*c*) Fruit canes and renewal spurs; canes vertical or bowed.

B. Head Pruning: Fan-shaped; Trellised

1. High trunk: Fruit canes and renewal spurs; canes descending.
2. Medium trunk: Fruit canes and renewal spurs; canes horizontal or ascending.

C. Cordon Pruning

1. Vertical: Spur; half-long; cane.
2. Horizontal-unilateral: Spur; half-long; cane.
3. Horizontal-bilateral: Spur; half-long; cane.

All possible combinations indicated by this table represent 24 variations. Some of these combinations, however, are not used and some are rare. The most common are shown in Figs. 23, 24, 25, 26 and 27.

Figure 23 B represents a headed, vase-formed vine, with a medium trunk and short fruit spurs. This is the most common system used in all parts of California and is suited for all small growing vines which bear on the lower buds, for most wine grapes and for Muscats. The unit of pruning in this case is a fruit spur of 1, 2, or 3 internodes, according to the vigor of the variety and of the individual cane.

Figure 23 A differs from 23 B only in the higher trunk and longer arms. It is commonly used for Tokay and other large

growing varieties, especially when growing in rich soil and when planted far apart.

Figure 23 C has the same form of body as A and B, except that the arms are somewhat less numerous. The unit of pruning is a short fruit cane of four to five internodes, accompanied by a renewal spur of one internode. It is suited for vigorous table grapes, which do not bear well on short spurs. It is used especially for the Cornichon and Malaga in rich soil. This is a difficult system to keep in good shape owing to the tendency

FIG. 23. Forms of head pruning: *A*, spur pruning with high trunk; *B*, spur pruning with medium trunk; *C*, half-long with medium trunk.

for all the vigor to go to the growth on the ends of the fruit canes. It is difficult to obtain vigorous canes on the renewal spurs. Occasional short pruning is usually necessary to keep the vines in proper shape.

Figure 24 A is similar to 23 C in form, but the number of arms is still further reduced to 2, 3, or at most 4. The unit of pruning is a fruit cane of $2\frac{1}{2}$ to $3\frac{1}{2}$ feet with its renewal spur. Owing to the length of the fruit canes they require support and are tied to a high stake.

This method is used in a large number of vineyards with Sultanina, Sultana and certain wine grapes, especially Semillon and Cabernet. It is not to be recommended in any case, as it has several very serious defects.

The difficulty of obtaining new wood from the renewal spurs is even greater than in the system shown in Fig. 23 C. The length and vertical position of the fruit canes cause the main growth and vigor of the vine to be expended on the highest shoots. The renewal spurs are thus so shaded that, even though their buds start, the shoots make but a weak growth. The result is that at the following pruning all the good new wood is at the top of the fruit canes of the previous year, where it cannot be utilized. The pruner has to choose then between reverting to spur pruning and getting no crop or using the weak growth from the renewal spurs for fruit canes, in which case he may get blossoms but little or no fruit of any value.

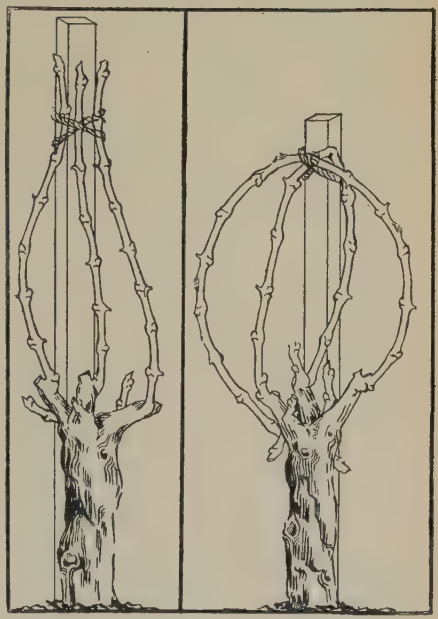

FIG. 24. Forms of head pruning: *A*, vertical fruit canes and renewal spurs; *B*, bowed fruit canes and renewal spurs.

Other defects of this method are that the fruiting shoots are excessively vigorous and therefore often tend to drop their blossoms without setting and the fruit when produced is massed together so that it ripens unevenly and is difficult to gather. It also requires a tall and expensive stake.

Figure 24 B represents an improvement on the last system. It differs only in the method of treating the fruit canes. These

are bent over in the form of a circle and tied by their middle part to a stake which may be smaller and lower than that needed for the vertical canes.

This bowing of the canes has several useful effects. The change of direction moderates the tendency of the vigor of the vine to expend itself only on the terminal shoots. More shoots therefore are formed on the fruit canes and as their vigor is somewhat decreased they tend to be more fruitful. The slight

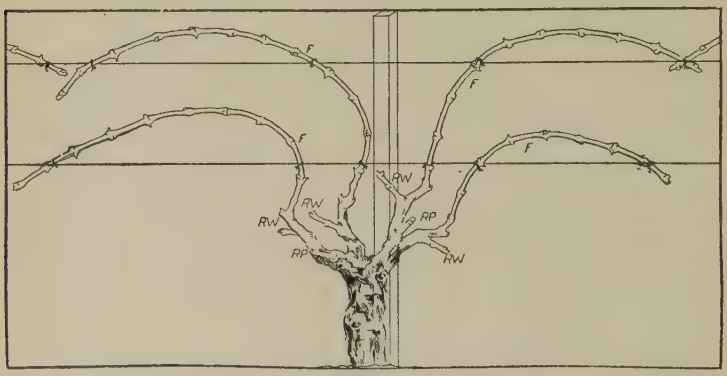

FIG. 25. Head pruning: fan-shaped head; fruit canes tied to horizontal trellis.

mechanical injury caused by the bending operates in the same direction.

The excess of vigor thus being diverted from the fruit canes causes the renewal spurs to form vigorous shoots, which soon grow above the fruit shoots and obtain the light and air they need for their proper development. This method is used successfully for certain wine grapes such as Riesling, Cabernet, and Semillon. It is unsuited to large vigorous varieties or for vines on rich soil planted wide apart. In these cases two fruit canes are usually insufficient and, if more are used, the grapes and leaves are so massed together that they are subject to mil-

dew and do not ripen evenly or well. The bowing and tying of the canes requires considerable skill and care on the part of the workmen.

The body, arms, and annual pruning of the system shown in Fig. 25 are similar to those of Fig. 24, with the exception that the arms are given a fan-shaped arrangement in one plane. It differs in the disposal of the fruit canes, which are supported by a trellis stretching along the row from vine to vine.

This method is largely used for the Sultanina (Thompson's Seedless), and is the best system for vigorous vines which require long pruning, wherever it is possible to dispense with cross cultivation. It is also suitable for any long-pruned varieties when growing in very fertile soil.

Figure 26 is a photograph of a four-year-old Emperor vine, illustrating the vertical cordon system. It consists of an upright trunk 4½ feet high with short arms and fruit spurs scattered evenly and symmetrically from the top to within fifteen inches of the bottom. This system is used in many Emperor vineyards in the San Joaquin Valley.

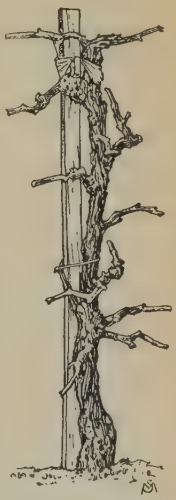

FIG. 26. Single vertical cordon with fruit spurs.

Its advantages are that it allows the large development of the vine and the large number of spurs which the vigor of the Emperor demands, without, on the one hand, crowding the fruit by the proximity of the spurs or, on the other hand, spreading the vine so much that cultivation is interfered with. It also permits cross cultivation.

One of its defects is that the fruit is subjected to various degrees of temperature and shading in different parts of the vine and the ripening and coloring are often uneven. A more vital defect is that it cannot be maintained permanently. The

arms and spurs at the top of the trunk tend to absorb the energies of the vine and the lower arms and spurs become weaker each year until finally no growth at all is obtained below. After several years, most of the vines therefore lose their character of cordons and become simply headed-vines with abnormally long trunks.

The cordon can be reëstablished in this case by allowing a vigorous sucker to develop one year from which to form a new trunk the next. The following year the old trunk is removed entirely. An objection to this method is that it makes very large wounds in the most vital part of the vine — the base of the trunk.

Figure 27 is a photograph of a four-year-old Colombar vine, illustrating the unilateral, horizontal cordon system. It con-

Fig. 27. Unilateral horizontal cordon with fruit spurs.

sists of a trunk about seven feet long, supported horizontally by a wire two feet from the ground. Arms and spurs are arranged along the whole horizontal part of the trunk.

This system accomplishes the same objects as the vertical cordon. It allows a large development of the vine and numerous fruit spurs without crowding. It is superior to the vertical cordon in the distribution of the fruit, which is all exposed to approximately the same conditions owing to the uniform distance from the ground of the fruit spurs. All parts of the trunk producing an annual growth of wood and fruit are equally exposed to light and the tendency of the growth to occur prin-

cipally at the part of the trunk farthest removed from the root is counteracted by the horizontal position. There is not the same difficulty therefore in maintaining this form of vine permanently that there is with the vertical cordon.

This system should not be used for small weak vines, whether the weakness is a characteristic of the variety or due to the nature of the soil. It is suited only to very vigorous varieties such as Emperor, Almeria, and the Persian grapes when growing far apart in rich, moist soil.

Periods of development.

The first year in the life of a vine is devoted to developing a vigorous root system; the next two or three years to building up a shapely trunk and head, and a like period to forming the full complement of arms. At the end of from five to nine years the framework of the vine is complete and should undergo no particular change of shape except a gradual thickening of trunk and arms.

There are, therefore, several periods in the life of the vine with varying objects, and the methods of pruning must vary accordingly. These periods do not correspond exactly to periods of time, so it may be misleading to speak of pruning a two-year-old or a three-year-old vine. One vine under certain conditions will reach the same stage of development in two years that another will reach only in three or four years under other conditions. The range of time of these periods is about as follows:

First period — Formation of a strong root system .	1 to 2 years
Second period — Formation of stem or trunk . .	1 year
Third period — Formation of head	2 to 3 years
Fourth period — Complete development of the arms	2 to 3 years
Total time of formation of framework	6 to 9 years

Under exceptionally favorable conditions the first and second periods may be included in the first year and a completely formed vine may be obtained in five years.

Before planting.

For planting, cuttings, one-year-old rooted vines, or bench grafts are used. In all cases, they need some attention from the pruner.

The usual way to prune a good rooted vine of average size having a single cane at the top and several good roots at the bottom is to shorten the cane to one or two buds and the roots to two or four inches, according to their size. Shortening the cane makes the vine less liable to dry out before rooting and forces the growth from the lower buds which produce more vigorous shoots. The roots are shortened so that there will be no danger of the ends being turned upwards when planted. If they are to be planted in a large hole, they may be left as long as five or six inches; if to be planted with a crowbar or dibble, they must be cut back to half an inch.

If the rooted vine has several canes, all but one should be removed entirely, and this one shortened to one or two eyes. The one left should be that which is strongest, has the best buds, and is the best placed. Where a horizontal cane is left, it should be cut back to the base bud. Otherwise the main growth may occur at a higher bud and the vine will have a crook which will result in a badly formed trunk.

If canes are growing from different joints, it is usually best to leave the lower cane if they are equally vigorous. This brings the buds from which growth will come nearer to the roots, and leaves less of the original cutting, which are advantages. The upper joint between the canes is, moreover, often more or less decayed or imperfect.

First growing season.

The treatment during the first spring and summer will depend on what growth the vines are expected to make and on whether the vines are staked the first year.

With cuttings and with both rooted vines and grafts where the growth will be moderate, staking the first year is unnecessary, though it has some slight advantages. In these cases, no pruning of any kind is necessary until the winter following the planting, except in the case of bench grafts. The pruning in the last case is confined to the removal of the suckers from the stock and roots from the cion. If the stocks have been well disbudded by the nurseryman, few suckers will develop. In moist soil, the cion roots may develop vigorously and must be removed before they grow too large, or they may prevent the proper development of the resistant roots.

The removal of roots should usually be done some time in July. For this purpose the hill of soil is scraped away from the union and after the cion roots and suckers are removed it is replaced. In this second hilling up, the union should be just barely covered so that the soil round the union will be dry and unfavorable to a second growth of roots. Later in the season, about September, the soil should be removed entirely from around the union and any new roots that may have formed removed. The union is then left exposed to harden and mature, so that it will pass the winter without injury.

First winter pruning.

At the end of the first growing season, an average good vine will have produced from three to five canes, the longest of which will be from two to three feet long.

Soon after the leaves have fallen in December or early in January the vines should be pruned. The method is precisely similar to that used for rooted vines before planting except that the main roots are not touched. All the canes are removed entirely except one. This one should be well matured, at least at the base, and should have well-formed eyes. It is shortened to two eyes. It is well also to cut off all shallow roots within three or four inches of the surface. This is neces-

sary in the case of grafted vines if any have escaped the summer root-cutting.

Some of the vines may have made an exceptionally large growth. Such vines may sometimes possess a cane large enough from which to start the trunk in the way described later for the second winter pruning.

Staking.

If the vines have not been staked before, the stakes should be driven soon after pruning and before the starting of the buds.

In order to preserve the alignment of the vineyard, the stakes should be driven on the same side of every vine at a uniform distance. The best distance is about two inches. If driven closer they may injure large roots or even the main underground stem if the vines have not been carefully planted vertically or slanting towards the side on which the stake is to be placed.

The side on which the stake should be placed depends on the direction of the prevailing winds during the growing season. This side is the leeward. That is, the stake should be so placed that the wind will press the vine towards the stake instead of away from it. This will much facilitate the work of keeping the vine upright and attached to the stake. If the vine is on the other side the pressure of the wind will stretch the string tight and the swaying of the vine will gradually wear the string until it breaks, necessitating retying. By carefully observing this rule, very few vines will require retying even if weak material like binding twine is used.

Second summer pruning.

Before the starting of the buds, in the spring following the planting, most of the vines appear about the same as when they were planted. There is, however, a very notable difference, in that they have well-developed root systems in the soil where they were formed. The result is that they make a much

more prompt and early start and will produce a much larger growth than they did the first season. For this reason they require very careful attention from the pruner during the spring and summer of the second season. Vines neglected at this time, in this respect, may make as large a growth, but a large part of it will be wasted, the vines will be misformed and it will require from one to two years longer to develop a suitable framework and to bring them into bearing, even though they are properly handled during subsequent years. The more vigorous the vines, the more necessary it is to handle them properly during this period.

The main object during this second growing season is to develop a single, strong, vigorous and well-ripened cane from which to form the permanent trunk of the vine.

This is done by concentrating all the energies of the vine into the growth of a single shoot. As soon as the buds start, or when the most precocious has developed a shoot of a few inches in length, the vines should be disbudded. This consists in rubbing off with the hand all buds and shoots except the two largest and best placed. The lowest, upright shoots are usually the best. Leave only those which will make a straight vine. It is better to leave less developed buds than a shoot which, when it grows, will make an awkward crook with the underground stem.

After this disbudding, the two shoots left will grow rapidly, as they receive all the energies of the root system. When the longest have grown from ten to fifteen inches, they should be tied to the stake. Unless this is done, they are liable to be broken off by any heavy wind, owing to their soft, succulent texture. Only the best placed and most vigorous of the two shoots should be tied up. If this shoot is growing upright and near the stake, this can be done without any danger of injuring it. In this case the second shoot should be removed. If the shoot has to be bent over in tying it to the stake it may

be injured. In such a case the second shoot should be allowed to grow until it is known whether the first has been injured. In case of injury the second shoot can be tied up the next time the vines are visited and the injured shoot removed.

At the tying up of the reserved shoots, all new shoots which have developed since the first disbudding should be removed. The shoots should be tied up loosely, as they are soft and easily injured, and they should be brought around carefully to the windward side of the stake.

The shoots will require tying once more when they have grown another foot or eighteen inches. There will then be two ties, one at two or three inches from the top of the stake and the other at about the middle. If the vines have a tall stake and are to be headed very high, another tying higher up may be needed later.

With vines making only a moderate growth, no other pruning will be needed until the winter. Exceptionally vigorous vines, however, may make a cane eight, ten or more feet long. Such a cane is heavy and is very likely to break the ropes by which it is attached to the stake. In this case it may break off at the bottom, or at least will form an awkward crook near the ground when it matures. In either case it is difficult to form a good trunk the following year. Even when the ties do not break, the cane will not be well suited for the commencement of a trunk, as the joints will be so long that it will be impossible to leave enough well-placed buds at the winter pruning.

Both these difficulties are avoided by timely topping. When such vigorously growing canes have grown twelve or eighteen inches above the top of the stake they are cut back about level with the stake. This is most conveniently done with a long-bladed knife or piece of split bamboo. After topping, the cane ceases to grow in length and laterals start at most of the joints. It is less exposed to the action of the wind, and the

PLATE XIII. — Dutchess ($\times \frac{2}{3}$).

laterals supply the buds needed for forming the vine at the winter pruning.

The result of the second season's growth, then, has been to produce a single vigorous cane with or without laterals. This is the cane which is to develop into the final and permanent trunk of the vine. It must not only be large and vigorous, but must be properly matured. If the vine is allowed to grow too late in the season, an early frost may destroy the unmatured cane, and much of the results of the year's growth will be wasted. Such a frost may indeed kill the entire vine. Grafted vines are particularly liable to injury from this cause, as if they are killed down to the union they are completely ruined. Ungrafted vines when killed to the ground may be renewed from a sucker next year. This sucker, however, is likely to grow with such vigor that it is even more liable to injury from an autumn frost than the original shoot.

This late growth is much more likely to occur with young vines than with old. The old vines stop growing earlier because their energies are directed into the crop, and as they produce a larger amount of foliage they draw more upon the moisture of the soil, which therefore dries out earlier.

Late growth of the young vines must be prevented and the wood matured before frost if possible. This is accomplished by means which promote the drying of the soil in autumn. Late irrigations should be avoided. Cultivation should usually stop by mid-summer. In very moist, rich soils, it is often an advantage to grow corn, sunflowers or similar crops between the rows of vines to take off the surplus moisture. In some cases it is good practice to let the summer weeds grow for the same purpose.

Second winter pruning.

With vines which have been treated as described and to which no accident has happened, the second winter pruning is

very simple. It consists simply in cutting back the single cane which has been allowed to grow to the height at which it is desired to head the vine.

The vine so pruned consists of a single cane which with the older wood at the base reaches nearly to the top of the stake, or fifteen inches. This if properly treated will develop into a vine with a trunk of about twelve inches, though this length can be modified slightly, as will be explained later.

This cane consists of about seven or eight joints or internodes, with an equal number of well-formed eyes and an indefinite number of dormant buds, principally near the base of the cane or junction of the one- and two-year-old wood. Only the buds on the upper half of this cane will be allowed to grow. These buds — about four — should give six to eight bunches of grapes and four, six, or eight shoots from which to form the spurs at the following winter pruning.

With a vine which has been cut back to form a high head, the cane is about twenty-four inches long and can be used to form a trunk eighteen inches high, though this height can be modified as in the last case. As with the shorter cane, only the buds on the upper half will be allowed to produce shoots. These — about six — should give ten to twelve bunches and the shoots necessary for the formation of spurs.

In all cases a full internode has been left above the top bud. This is done by cutting through the first bud above the highest which it is desired to have grow. This cut is made in such a way as to destroy the bud but to leave the diaphragm intact and part of the swelling of the node. This upper internode is left partly to protect the upper bud, but principally to facilitate tying. By making a half-hitch around this internode, the vine is held very firmly. If the swelling at the node of the destroyed bud is not left, many vines will be pulled out of the hitch when they become heavy with leaves and supple with the flow of sap in the spring.

In tying the vines, no turns or hitches must be made around any part except this upper internode. A hitch below the top bud will result in a crook-necked vine, as the top will bend over in the summer under the weight of the foliage. A hitch lower down is even more harmful, as it will girdle and strangle the vine.

A second tie about half way from the upper to the ground is always necessary to straighten the cane. Even if the cane is straight when pruned, a second tie is needed to keep it from curving under the pressure of leaves and wind in the spring. For high-headed vines three ties are usually necessary.

For the top tie, wire is particularly suitable. It holds better than twine and does not wear. Even though it is not removed, it does no harm, as the part around which it is wound does not grow. The lower ties should be of softer material, as wire has a tendency to cut into the wood. They should be placed so that the cane is able to expand as it grows. With thin and especially with round stakes this means that the tie must be loose. With large, square stakes there is usually sufficient room for expansion, even when the twine is tied tight.

Third summer pruning.

During the third season, average well-grown vines will produce their first considerable crop and develop the canes from which will be formed the first arms.

Such a vine, soon after the starting of the buds in spring, will have one vigorous shoot about three inches long grown from the old wood and five fruit buds started above on the cane. All the buds and shoots below the middle of the cane should be removed.

This will leave the four or five fruit buds and will give the vine the opportunity to produce eight or ten bunches of grapes. These buds will produce also at least four or five shoots. If the vine is very vigorous and the season favorable, they may produce eight, ten or more.

When the five shoots grow, the height of the head will be determined at the next winter pruning by which of the corresponding canes are left as spurs. If the highest two canes are cut back to spurs and all others removed, the vine will be headed as high as possible, as these two spurs form the two first arms which determine the length of the trunk. If the lowest two canes are chosen and all of the vine above them removed, the trunk will be made as low as possible. Intermediate heights can be obtained by using some other two adjacent canes and removing the rest. It is often advisable to leave some extra spurs lower than it is desired to head the vine and to remove these lower spurs the following winter after they have borne a crop. For example, the three or four upper canes might be left, if the vine is vigorous enough, and the lowest one or two of these removed at the next pruning. This, however, is not often necessary with properly handled vines and is objectionable because it makes large wounds in the trunk.

Third winter pruning.

At the end of the third season's growth the vine should have a straight, well-developed trunk with a number of vigorous canes near the top from which to form the arms.

Figure 28 represents a well-grown vine at this period. No shoots have been allowed to grow on the lower part of the trunk and the five buds allowed to grow above have produced nine vigorous canes. The pruner should leave enough spurs to supply all the fruit buds that the vine can utilize. The number, size and thickness of the canes show that the vine is very vigorous and can support a large crop. It will depend somewhat on the variety how many buds should be left. For a variety whose bunches average one pound, and which produces two bunches to the shoot, twelve fruit buds should give about twenty-four pounds, or about seven tons per acre, if the

vines are planted 12 by 6 feet, as these were. The number of spurs will depend on their length. Six spurs of two buds each

FIG. 28. Three-year-old vine ready for pruning.

will give the required number, but as some of these canes are exceptionally vigorous they should be left a little longer, in which case a smaller number of spurs will suffice.

When the number and length of the spurs are decided on, the canes should be chosen which will leave these spurs in the most suitable position for forming arms. This position will depend on whether we want a vase-form or fan-shaped vine. In the first case, we choose those which will distribute the spurs most evenly and symmetrically on all sides, avoiding any which cross or point downwards.

FIG. 29. Vine of Fig. 28 after pruning for vase-formed head.

In the second case, we choose only those canes which run in the direction of the trellis, avoiding canes which stick out between the rows. Downward pointing canes may be used in this case.

Figure 29 shows the vine after pruning for a vase-formed head. The pruner has used two of the strongest canes to form

two three-bud spurs and three of medium vigor to form three two-bud spurs. The head is of good shape, though some of the spurs are a little too low. One, two, or three of these can be removed at the following winter pruning, and the permanent arms and head of the vine formed from canes which develop on the two highest spurs. If the vine were too high, the head could be developed the next year from the three lowest spurs and the upper part removed.

A B

FIG. 30. Three-year-old vines: *A*, pruned for a vase-formed, and *B*, for a fan-shaped head.

Figure 30 shows vines of the same age of practically perfect shape. Less spurs have been left because the vines were less vigorous. It is easier to properly shape vines which make only a moderate growth during the first three seasons. On the other hand, very vigorous vines can finally be brought into practically perfect shape and the somewhat larger and more numerous wounds necessary are more easily healed by a vigorous vine.

Pruning after the third winter.

For the pruner who understands the pruning of young vines and has brought them to approximately the form represented in Figs. 29 and 30, the subsequent winter pruning is very simple. It involves, however, one new idea — the distinction between fruit and sterile wood.

Up to the third winter pruning, this distinction is not necessary; first, because practically all the wood is fruit wood, and second, because the necessity of forming the vine controls the choice of wood. From this time on, however, this distinction

must be carefully made. At each winter pruning a number of spurs of fruit wood must be left to produce the crop to be expected from the size and vigor of the vine. Besides these fruit spurs, it may be necessary to leave spurs of sterile wood to permit of increasing the number of fruit spurs the following year.

This will be made clear by comparing Figs. 30 A and 31. Figure 30 A shows a vine at the third winter pruning with two fruit spurs of two buds each and one fruit spur of one bud — five fruit buds in all.

If these five fruit buds all produce vigorous shoots during the following summer, they will supply five canes of fruit wood which can be used to form five fruit spurs at the following winter pruning, which will be about the normal increase necessary. Some of these fruit buds, however, may produce weak shoots or shoots so badly placed that they would spoil the shape of the head if used for spurs. Other shoots, however, will be produced from base, secondary and adventitious buds which, while less fruitful, can be used to form spurs for the starting of new arms.

FIG. 31. Four-year-old vine pruned for vase-formed head.

Figure 31 shows a vine after the fourth winter pruning which had developed from a vine similar to that shown in Fig. 30 A. From the three fruit spurs left the previous year four canes have been chosen for the fruit spurs of this year. The old spur on the left has furnished two new spurs and the two old spurs at the right each one new spur. The pruner, judging that the vine is sufficiently vigorous to stand more wood, has formed two spurs from water sprouts which, while not likely to produce much fruit the first season,

will supply fruit wood for the following year. The result is a very well-shaped vine with six almost perfectly balanced spurs. These spurs will develop into permanent arms, some of them furnishing finally two or three.

Figure 32 shows a high-headed vine of the same age. It has five spurs, of which four are fruit spurs and one a spur of sterile wood left to shape the vine. The two more or less horizontal spurs on the right will bear fruit the following autumn and will be removed entirely at the following winter pruning, as they are badly placed. The arms of the vine will then be developed from the three upright spurs, which are excellently placed.

FIG. 32. Four-year-old vine pruned for high vase-formed head.

Each year thereafter the same process must be followed. First, enough fruit spurs, as well placed as possible, must be left to produce the crop. Second, on most vines supplementary spurs of sterile wood must be left to supply more arms where they are needed, and finally, when the full complement of arms has developed, to supply new arms to replace those which have become too long or are otherwise defective.

Fan-shaped vines.

With headed vines, the treatment up to the third winter is the same except for the variations in the height of the head. At the third winter pruning, however, the formation of the head commences, and the pruner determines whether it shall be vase-formed or fan-shaped. The production of a vase-formed head has already been described.

At the third winter pruning, the vine should be pruned to two spurs, as shown in Fig. 30 B. More vigorous vines should *not* be given more spurs, as in Figs. 29 and 30 A, but the spurs

should be made longer, with four, five, or even six eyes in some cases. This is in order to obtain some fruit, which might not be obtained from long pruning varieties by leaving many spurs. With extremely vigorous vines one fruit cane may be left at this pruning. The wires of the trellis should be put up this year, if this has not already been done.

Fig. 33 A and 33 B illustrates the second step in the production of a fan-shaped head. This form of head is used only for trellised vines and long-pruned varieties. The formation of the head and the management of the fruit canes are therefore conveniently discussed together.

FIG. 33. *A*, before pruning; *B*, after pruning.

By comparing the pruned vine, Fig. 33 B, with the unpruned, Fig. 33 A, the method of pruning will be made clear. The unpruned vine shows two arms, the spurs of the previous year, from one of which have grown three vigorous canes and from the other two somewhat less vigorous. The pruned vine shows a complete unit, that is, a fruit cane with its accompanying renewal spur on the vigorous side and a spur for the production of fruit wood for the following year on the other side. If the vine had been more vigorous two complete units would have been left and one or two extra spurs.

As the form of the vine is determined by the renewal spurs, special attention should be paid to their position. In this case, the middle cane on one arm and the lower cane on the other

have been used for renewal spurs. This brings them both to the same height above the ground and determines the place of the permanent arms. The next year each of these spurs will furnish a fruit cane and one or two renewal spurs. The arms will thus in two or three years be increased to four, or, with very large vines, to six. These spurs should be chosen as nearly as possible in the plane of the trellis, that is, they should not project out sideways. Figure 25 shows vines of this kind of full size and in full bearing.

The fruit canes also should be as nearly as possible in the direction of the trellis, though this is not so important, as they can be bent over to the wire when tied up, and in any case they are removed the next year.

Double-headed vines.

Some growers attempt to arrange the arms of their vines in two stages, one above the other, forming double-headed or two-crowned vines. The method is applied to both vase-formed and trellised vines. It is open to the same criticisms as the vertical cordon, the chief of which is that it cannot be maintained permanently. The lower head or ring of arms finally becomes weak and fails to produce wood.

It is easier to maintain in trellised vineyards and has some advantages, the chief of which is that it makes it easier to keep the vine in the single plane and to prevent arms getting into the inter-rows. The double trunk is not necessary and is, in fact, a disadvantage, as one trunk has a tendency to grow at the expense of the other.

Vertical and bowed canes.

Figure 24 A shows a long-pruned vine in which the fruit canes have been tied vertically to a tall stake. This is a method used commonly in many vineyards. The unit of pruning is the same as in the method just described, consisting of a fruit cane and

a renewal spur. The framework of the vine consists of a trunk of medium height, with a vase-formed head consisting of three or four arms. The defects of this system have been pointed out on page 155.

It is used with fair success with seedless Sultanas and with some wine grapes such as Colombar, Semillon, Cabernet, and Riesling, in the hands of skillful pruners. The results with Sultanina are very unsatisfactory.

By this method, on most of the vines, the fruit canes start from high up near the middle of the stake, and are therefore too short for the best results. The canes which start from low down are in most cases suckers, and therefore of little value for fruit bearing.

Figure 24 B shows a vine with bowed canes. The method of pruning is exactly the same as in the method just described. The bowing of the canes, however, overcomes some of the defects of that method. It is used regularly in many wine grape vineyards of the cooler regions. It is unsuited for very vigorous vines in rich soil.

Vertical cordons.

In head pruning, the treatment of young vines up to the second or third winter pruning is identical for all systems. In cordon pruning the treatment for the first and second is also the same. That is, the vine is cut back to two buds near the level of the ground until a cane sufficiently long to serve for the formation of the trunk is obtained.

In the vertical cordon the trunk is three to four feet long instead of one to two, as in head pruning. This makes it necessary to have a longer and more vigorous cane to start with. It may require a year longer to obtain this. That is to say, at the end of the second season's growth many vines will not have a single cane sufficiently developed to give the necessary three and one-half feet of well-ripened wood and properly developed

buds. At the second winter pruning, therefore, it will often be necessary to cut the vine back to two buds, as at the first winter pruning.

Finally, a cane of the required length will be obtained. The vine is then formed as already described for the second winter pruning of headed vines, except that the cane is left longer. When such a vine is pruned, spurs are left at intervals along the trunk, as shown in Fig. 34. Each of these spurs is a fruit spur and is also the commencement of an arm. The future treatment of these arms is the same as that of the arms in head pruning.

FIG. 34. Vertical cordon, young vine pruned.

Horizontal cordons.

During the first two or three years, vines which are to be given the form of horizontal cordons are treated exactly as for vertical cordons, that is, they are pruned back to two buds each winter and the growth forced by disbudding into a single cane during the summer.

As soon as a well-ripened cane of the required length is obtained, it is tied to a wire stretched horizontally along the row at from fifteen to twenty-four inches from the ground.

For this system of pruning, the rows should be twelve to fourteen feet apart and the vines six, seven, or eight feet apart in the rows. As the cordon or trunk of each vine should reach the next vine, it will have to be six to eight feet long. The best shape is obtained when the trunk is all formed one year from a single cane. It is necessary, however, sometimes to take two years for the formation of the trunk. In any case, the cane first tied down should reach at least half way to the next vine. The following year a new cane from the end of this should be used to complete the full length of the trunk.

In attaching the cane to the wire, it must be bent over in a gentle curve and care taken not to break or injure it. The proper form of the bend is shown in Figs. 27 and 35. Sharp bends should be avoided.

The cane should be placed on top of the wire, but should not be twisted around it. The end should be tied firmly and

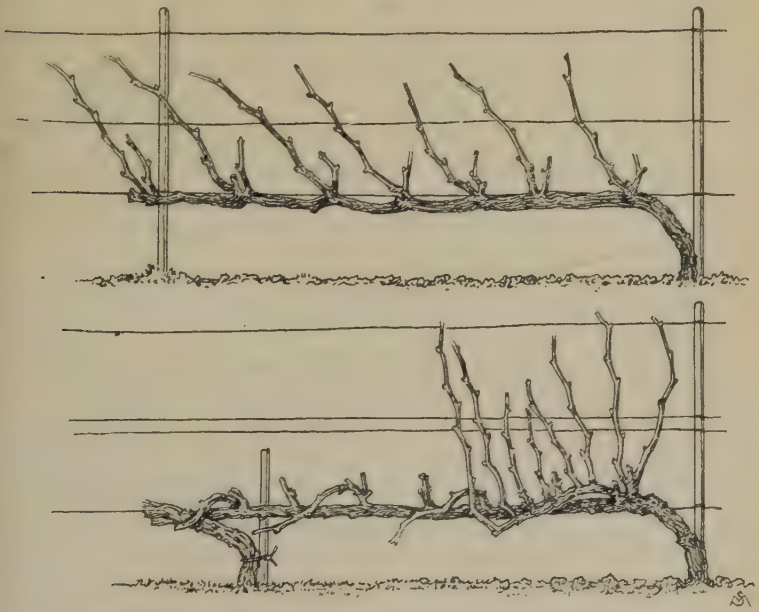

FIG. 35. Unilateral horizontal cordon with half-long pruning.

the rest of the cane supported by strings tied loosely in order to avoid girdling when the cane grows.

In the following spring, most of the buds on a good cane will start. If the cane is short jointed, some of the shoots should be removed and only those shoots allowed to develop which are conveniently situated for permanent arms. If the vines are to be short pruned, the arms should be developed every eight to

twelve inches from a few inches beyond the bend to the extreme end. For long pruning, the arms should be farther apart, twelve to twenty inches. Shoots starting from the top of the cane and growing vertically upwards are to be preferred.

As the shoots develop, the strongest should be pinched repeatedly, if necessary. This will tend to force the growth of the weaker shoots and to equalize the vigor of all. At the end of the season, there should be from five to ten canes growing on each cordon of full length. These canes are then pruned back to two or three buds, or a little longer for long-pruned varieties.

During the following spring and summer, the vines should be carefully suckered and unnecessary water sprouts removed. Any shoots coming from the lower side of the cordon should be removed early to strengthen the growth in the shoots on the upper side. Such vines are apt to become dry or decayed on the upper side. At the end of this year, which should be the fourth or fifth from planting at the latest, the cordon will be fully formed and the final style of pruning can be applied. A short-pruned cordon vine is shown in Fig. 27. The arms and spurs are a little too numerous and too close together. If this vine required the number of buds shown it would have been better to have left the fruit spurs longer and to have left fewer and shorter wood spurs.

The upper vine of Fig. 35 shows a cordon pruned half long. This is an excellent system for Malaga, Emperor, and Cornichon when growing in very fertile soil. It gives the half-long fruit canes, which these varieties need to produce good crops. The fruit canes may be attached to a wire twelve or fifteen inches above the cordon or bent down and tied to the cordon itself, as in the lower vine of the figure. The first method is the more convenient, but the second is necessary where there is difficulty in obtaining satisfactory growth from the renewal spurs. When the fruit canes are tied down, as indicated in the lower vine, renewal spurs may not be needed, as vigorous

shoots will usually be obtained from the lower buds of the fruit canes.

Choice of a system.

In choosing a system, we must consider carefully the characteristics of the particular variety we are growing. A variety which bears only on the upper buds must be pruned "long," that is, must be given fruit canes. It should be noted that many varieties, such as Petite Sirah, which will bear with short pruning when grafted on resistant roots require fruit canes when growing on their own roots. In general, grafted vines require shorter pruning than ungrafted. If pruned the same, the grafted vines may overbear and quickly exhaust themselves. This seems to be the principal reason for the frequent failure of Muscat vines grafted on resistant stock. The cultural conditions also affect the vine in this respect. Vines made vigorous by rich soil, abundant moisture, and thorough cultivation require longer pruning than weaker vines of the same variety.

The normal size of the bunch is also of importance. This size will vary from one-quarter of a pound to 2 or 3 pounds. It is difficult to obtain a full crop from a variety whose bunches are very small without the use of fruit canes. Spurs will not furnish enough fruit buds without crowding them inconveniently. On the other hand, some shipping grapes may bear larger crops when pruned long, but the bunches and berries may be too small for the best quality.

The possibilities of development vary much with different varieties. A Mission or Flame Tokay may be made to cover a quarter of an acre and develop a trunk four or five feet in circumference. A Zinfandel vine under the same conditions would not reach a tenth of this size in the same time. Vines in a rich valley soil will grow much larger than on a poor hillside. The size and shape of the trunk must be modified accordingly and adapted to the available room or number of vines to the acre.

The shape of the vine must be such as to protect it as much as possible from various unfavorable conditions. A variety susceptible to oïdium, like the Carignane, must be pruned so that the fruit and foliage are not unduly massed together. Free exposure to light and air are a great protection in this respect. The same is true for varieties like the Muscat, which have a tendency to "coulure" if the blossoms are too moist or shaded. In frosty locations, a high trunk will be a protection, as the air is always colder close to the ground.

The qualities required in the crop also influence our choice of a pruning system. With wine grapes, even, perfect ripening and full flavor are desirable. These are obtained best by having the grapes at a uniform height from the ground and as near to it as possible. The same qualities are desirable in raisin grapes, with the addition of large size of the berries. With shipping grapes, the size and perfection of the berries and bunches are the most essential characteristics. The vine, therefore, should be so formed that each bunch hangs clear, free from injurious contact with canes or soil and equally exposed to light and air.

The maximum returns in crop depend on the early bearing of young vines, the regularity of bearing of mature vines and the longevity of the vineyard. These are insured by careful attention to all the details of pruning, but are possible only when the vines are given a suitable form.

The running expenses of a vineyard depend in a great measure on the style of pruning adopted. Vines of suitable form are cultivated, pruned and the crop gathered easily and cheaply. This depends also both on the form of vine adopted and on care in details.

It is impossible, therefore, to state for any particular variety or any particular location the best style of pruning to be adopted. All that can be done is to give the general characteristics of the variety and to indicate how these may be modified by grafting, soil or climatic or other conditions.

The most important characteristic of the variety in making a choice of a pruning system is whether it normally or usually requires short, half-long, or long pruning. With this idea, the principal grapes grown in California, together with all those grown at the Experiment Station on which data exist, have been divided into five groups in the following list:

1. *Varieties which require long pruning under all conditions.* — Clairette blanche, Corinth white and black, Seedless Sultana, Sultanina white (Thompson's Seedless) and rose.

2. *Varieties which usually require long pruning.* — Bastardo, Boal de Madeira, Chardonay, Chauché gris and noir, Colombar, Crabbe's Black Burgundy, Durif, Gamais, Kleinberger, Luglienga, Marsanne, Marzemino, Merlot, Meunier, Muscadelle de Bordelais, Nebbiolo, Pagadebito, Peverella, Pinots, Rieslings, Robin noir, Ruländer, Sauvignon blanc, Semillon, Serine, Petite Sirah, Slancamenca, Steinschiller, Tinta Cao, Tinta Madeira, Trousseau, Verdelho, Petit Verdot, Wälcherisling.

3. *Varieties which usually require short pruning.* — Aleatico, Aligoté, Aspiran, Bakator, Bouschets, Blaue Elbe, Beba, Bonarda, Barbarossa, Catarattu, Charbono, Chasselas, Freisa, Frontignan, Furmint, Grand noir, Grosseblaue, Green Hungarian, Malmsey, Mantuo, Monica, Mission, Moscatello fino, Mourisco branco, Mourisco preto, Negro amaro, Palomino, Pedro Zumbon, Perruno, Pizzutello di Roma, Black Prince, West's White Prolific, Quagliano, Rodites, Rozaki, Tinta Amarella, Vernaccia bianca, Vernaccia Sarda.

4. *Varieties which require short pruning under all conditions.* — Aramon, Burger, Chardonay, Chauché gris and noir, Colombar, Crabbe's Black Burgundy, Durif, Black Morocco, Mourastel, Muscat of Alexander, Napoleon, Picpoule blanc and noir, Flame Tokay, Ugni blanc, Verdal, Zinfandel.

5. *Varieties of table grapes which usually require half-long or cordon pruning.* — Almeria (Ohanez), Bellino, Bermestia bianca

and violacea, Cipro nero, Dattier de Beirut, Cornichon, Emperor, Black Ferrara, Malaga, Olivette de Cadenet, Pis-de-Chevre blanc, Schiradzouli, Zabalkanski.

These lists must not be taken as indicating absolutely for all cases how these varieties are to be pruned. They simply indicate their natural tendencies. Certain methods and conditions tend to make vines more fruitful. Where these occur, shorter pruning than is indicated may be advisable. On the other hand, other methods and conditions tend to make the vines vigorous at the expense of fruitfulness. Where these occur, longer pruning may be advisable.

The more usual factors which tend towards *fruitfulness* are:

Grafting on resistant vines, especially on certain varieties such as those of Riparia and Berlandieri;

Old age of the vines;

Mechanical or other injuries to any part of the vine;

Large development of the trunk, as in the cordon systems.

The more usual factors which tend towards *vigor* at the expense of fruitfulness are:

Rich soil, especially large amounts of humus and nitrogen;

Youth of the vines;

Excessive irrigation or rainfall (within limits).

In deciding what system of pruning to adopt, all these factors, together with the nature of the vine and the uses to which the fruit is to be put, must be considered. It is best when the vineyard is started to err on the side of short pruning. While this may diminish slightly the first one or two crops, the vines will gain in vigor and the loss will be made up in subsequent crops. If the style of pruning adopted results in excessive vigor of the vines, it should be gradually changed in the direction of longer pruning with the object of utilizing this vigor in the production of crop.

This change should be gradual, or the risk is run of injuring the vitality of the vines by one or two excessively heavy crops.

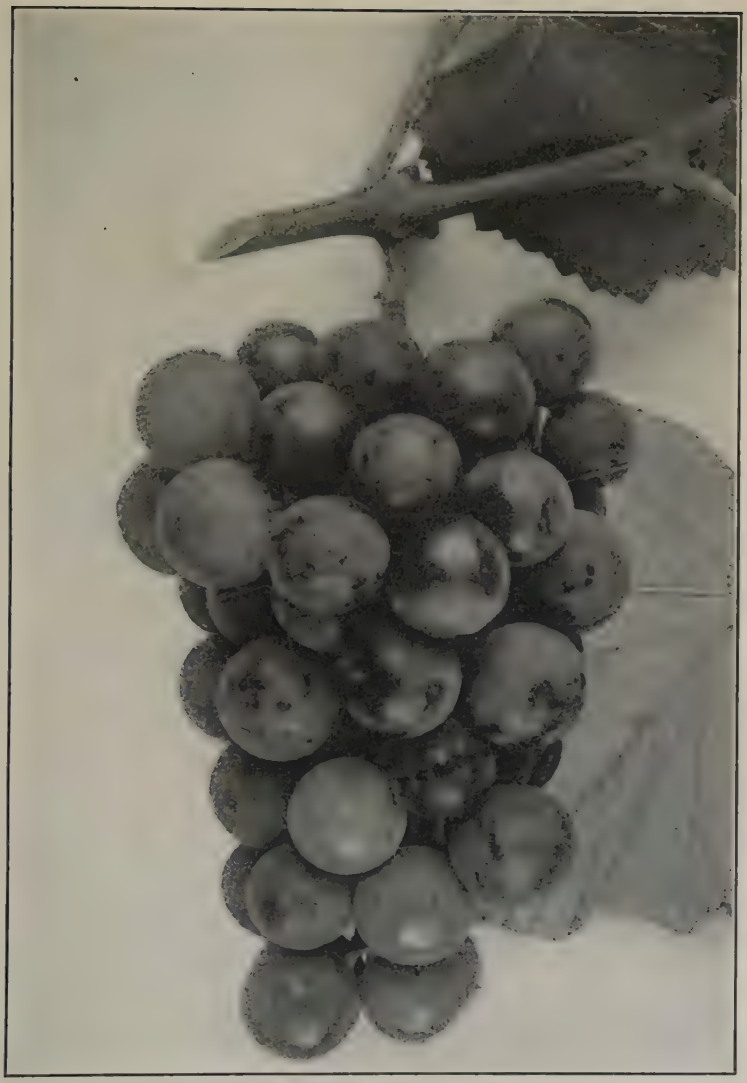

PLATE XIV. — Eaton ($\times \frac{4}{5}$).

Finally, each year the condition of the individual vine should determine the kind of pruning to be adopted. If the vine appears weak, from whatever cause, it should be pruned shorter or given less spurs or fruit canes than the year before. On the contrary, if it appears unnecessarily vigorous, more or longer spurs or fruit canes should be left. Every vine should be judged by itself. It is not possible to give more than general directions for the pruning of the whole vineyard. It cannot be well pruned unless the men who do the actual pruning are capable of using sufficient judgment to properly modify their methods for each individual vine.

CHAPTER X

EUROPEAN GRAPES IN EASTERN AMERICA

As we have seen, there were many efforts to grow European grapes in America during the first two centuries in the settlement of the country. The various attempts, some involving individuals, others corporations and in early days even colonies, form about the most instructive and dramatic episodes in the history of American agriculture. All endeavors, it will be remembered, were failures, so dismally and pathetically complete that we are wont to think of the two hundred years from the first settlements in America to the introduction of the Isabella, a native grape, as time wasted in futile culture of a foreign fruit. The early efforts were far from wasted, however, for out of the tribulations of two centuries of grape-growing came the domestication of our native grapes, one of the most remarkable achievements of agriculture.

The advent of Isabella and Catawba wholly turned the thoughts of vineyardists from Old World to New World grapes. So completely, indeed, were viticulturists won by the thousand and more native grapes, that for the century which followed no one has planted Old World grapes east of the Rockies, while vineyards of native species may be found North and South from the Atlantic to the Pacific.

Meanwhile, much new knowledge has come to agriculture, old fallacies have received many hard knocks and chains of tradition in which the culture of plants was bound, have been broken. In no field of agriculture have workers received greater aid from science than in viticulture. Particularly

is this true of the diseases of the vine. The reports of the old experimenters were much the same, "a sickness takes hold of the vines and they die." What the sickness was and whether there were preventatives or remedies, no one knew a hundred years ago. But in the last half century we have learned much about the ills of grapes and now know preventatives or remedies for most of them. We know also that the early vine-growers failed, in part at least, because they followed empirical European practices. Is it not possible that with the new knowledge we can now grow European grapes in eastern America? The New York Agricultural Experiment Station has put this question to test, with results indicating that European grapes may now be grown successfully in eastern America. The following is an account of the work with this fruit at the New York Station.

European Grapes at the New York Experiment Station [1]

In the spring of 1911, the Station obtained cuttings of 101 varieties of European grapes from the United States Department of Agriculture and the University of California. The cuttings obtained were grafted on the roots of a heterogeneous collection of seedlings, five years set, representing a half dozen species of Vitis. These stocks had little to recommend them except that all were vigorous, well established and all were more immune to phylloxera than the Old World varieties. From four to six grafts of each of the hundred varieties were made and a stand of 380 vines resulted, the percentage of loss being exceedingly small. The success in grafting was probably due to the method used, the value of which had been proved in previous work on the Station grounds. The method of grafting and details of care follow:

[1] The following account is founded on work carried on by the author at the N. Y. Agr. Exp. Sta., accounts of which have been given before several horticultural societies in 1916, 1917 and 1918.

Details of care.

In grafting, the earth was removed from the plants to a depth of two or three inches. The vines were sawed squarely off below the surface of the ground. The stock was then split for a cleft graft. Two cions, made as described on page 46, were inserted in each cleft and tied in place with waxed string. Wax was not used as it does not stick in grafting grapes, because of the bleeding of the stock. After setting the cion, the earth was replaced and enough more of it used to cover stock and cion to prevent evaporation. This method of grafting is available to those who have old vineyards. It is so simple that the veriest tyro can thus graft grapes. Were young plants or cuttings used as stocks, some method of bench grafting would, of course, be resorted to.

The cultivation and spraying were precisely that given native grapes. There has been no coddling of vines. The fungous diseases which helped to destroy the vineyards and vexed the souls of the old experimenters were kept in check by two sprayings with bordeaux mixture; the first application was made just after the fruit set, the second when the grapes were two-thirds grown. Some years a third spraying with a tobacco concoction was used to keep thrips in check. Phylloxera was present in the vineyard but none of the varieties seemed to suffer from this pest. The stocks used were not those best suited either to the vines grafted on them or to resist phylloxera. Unquestionably some of the standard sorts used in France and California from *Vitis rupestris* or *Vitis vulpina*, or hybrids of these species, would give better results. From theoretical consideration, it would seem that the *Vitis vulpina* stocks should be best suited to the needs of eastern America.

It was thought by the old experimenters that European grapes failed in New York because of unfavorable climatic conditions. It was said that the winters were too cold and the sum-

mers too hot and dry for this grape. During the years the Station vineyard of Viniferas has been in existence, there have been stresses of all kinds of weather to which the variable climate of New York is subject. Two winters have been exceedingly cold, killing peach and pear trees; one summer gave the hottest weather and hottest day in twenty-five years; the vines have withstood two severe summer droughts and three cold, wet summers. These test seasons have proved that European grapes will stand the climate of New York as well as the native varieties except in the matter of cold; they must have winter protection.

To growers of American grapes, the extra work of winter protection seems to be an insuperable obstacle. The experience of several seasons in New York shows that winter protection is a cheap and simple matter. Two methods have been used; vines have been covered with earth and others have been wrapped with straw. The earth covering is cheaper and more efficient. The vines are pruned and placed full length on the ground and covered with a few inches of earth. The cost of winter protection will run from two to three cents a vine. Since European vines are much more productive than those of American grapes, the added cost of winter protection is more than offset by the greater yield of grapes. Trellising, also, is simpler and less expensive for the European grapes, helping further to offset the cost of winter protection.

Pruning.

It is apparent at once that European grapes must have special treatment in pruning if they are to be laid on the ground annually. Several modifications of European and California practices can be employed in the East to bring the plants in condition for winter laying-down. All methods of pruning must have this in common; new wood must be brought up from the base of the plant every year to permit bending the

plant. This can be done by leaving a replacing spur at the base of the trunk. If two-eye cions are used when the plants are grafted and both buds grow, the shoot from the upper can be used to form the main trunk, while that from the lower bud will supply the replacing spur. Each year all but one of the canes coming from this spur are removed and the remaining one is cut back to one or two buds until the main trunk begins to be too stiff to bend down readily, then one cane from the spur is left for a new trunk and another is pruned for a new renewal spur.

The main trunk is carried up only to the lower wire of the trellis. At the winter pruning, two one-year canes are selected to be tied along this wire, one on each side, and the two renewal spurs chosen for tying up and new renewal spurs left. For the best production, different varieties require different lengths of fruit canes, but the work at Geneva has not progressed far enough so that recommendations can be made for particular varieties. It has been found best, however, to prune weak vines heavily and vigorous ones lightly. Under normal conditions, from four to eight buds are left on each cane, depending on the vigor of the vine. With some of the older seedlings used for stocks in 1911 which were so large that two cions were used, and in many of those where the roots seemed to have sufficient vigor to support the larger top, two trunks were formed, one from each graft. By spreading these into a V and making the inner arms shorter, very satisfactory results were secured.

The type of growth in Vinifera is different from that of native grapes. The young shoots which spring from the one-year canes, instead of trailing to the ground or running out along the trellis wires, grow erect. Advantage must be taken of this in the pruning system adopted in the East. The canes and the renewal spurs as described above are tied along the lower wire; then the young shoots which come from these grow upward to the second wire. When the shoots are four to

six inches above this wire, they are pinched off just above the wire and any which have not already fastened themselves are tied to prevent the wind breaking them off. At the same time, if any of the axial buds on the shoots have begun to form secondary shoots, they are rubbed off, beginning with the node next above the upper cluster and going down to the old cane. This gives the cluster more room and better light. Soon after the first heading-back, the upper buds of the young shoot start lateral growth. The secondary branches usually grow upright and when they are several inches high they are topped with a sickle. This heading-back results in stockier and more mature canes for the following year, and if properly done adds to the fruitfulness of the vine and the fruit matures better.

General considerations.

The grower of European grapes grafted on American vines may be prepared to be surprised at the growth the vines make. At the end of the first season, the grafts attain the magnitude of full-sized vines; the second season they begin to fruit more or less abundantly, and the third year they produce approximately the same number of bunches as a Concord or Niagara vine; and, as the bunches of most varieties are larger than those of the American grapes, the yield, therefore, is greater. The European varieties, also, may be set more closely than the American sorts, since they are seldom such rampant growers.

It is too early to reason from this short experiment that we are to grow varieties of European grapes commonly in the East, but the behavior of the vines under discussion seems to indicate that we may do so. At the New York Station, the European varieties are as vigorous and thrifty as American vines and quite as easily managed. Why may we not grow these grapes if we protect them from phylloxera, fungi and cold? In Europe, there are varieties of grapes for nearly every soil and condition

in the southern half of the continent. In eastern Europe and western Asia, the vines must be protected just as they must be protected here. It seems almost certain that from the many sorts selected to meet the various conditions of Europe, we shall be able to find kinds to meet the diverse soils and climates of this continent. And here we have one of the chief reasons for wishing to grow these grapes that American grape-growing may not be so localized as at present. Probably we shall find that European grapes can be grown under a greater diversity of conditions than native varieties.

The culture of European grapes in the East gives this region essentially a new fruit. If any considerable degree of success attends their culture, wine-making in eastern America will be revolutionized, for the European grapes are far superior to the native sorts for this purpose. Varieties of these grapes have a higher sugar- and solid-content than do those of the American species and for this reason, as a rule, keep longer. We may thus expect that through these grapes the season for this fruit will be extended. The European varieties are better flavored, possessing a more delicate and a richer vinous flavor, a more agreeable aroma, and are lacking in the acidity and the obnoxious foxy taste of many American grapes. Many consumers of fruit will like them better and the demand for grapes thus will be increased.

The advent of the European grape in the vineyards of eastern America ought to greatly increase the production of hybrids between this species and the American species of grapes. As we have seen, there are many such hybrids, but curiously enough scarcely more than a half dozen varieties of European grapes have been used in crossing. Most of these have been greenhouse grapes and not those that could be expected to give best results for vineyard culture. As we come to know the varieties best adapted to American conditions, we ought to be able to select European parents to better advantage

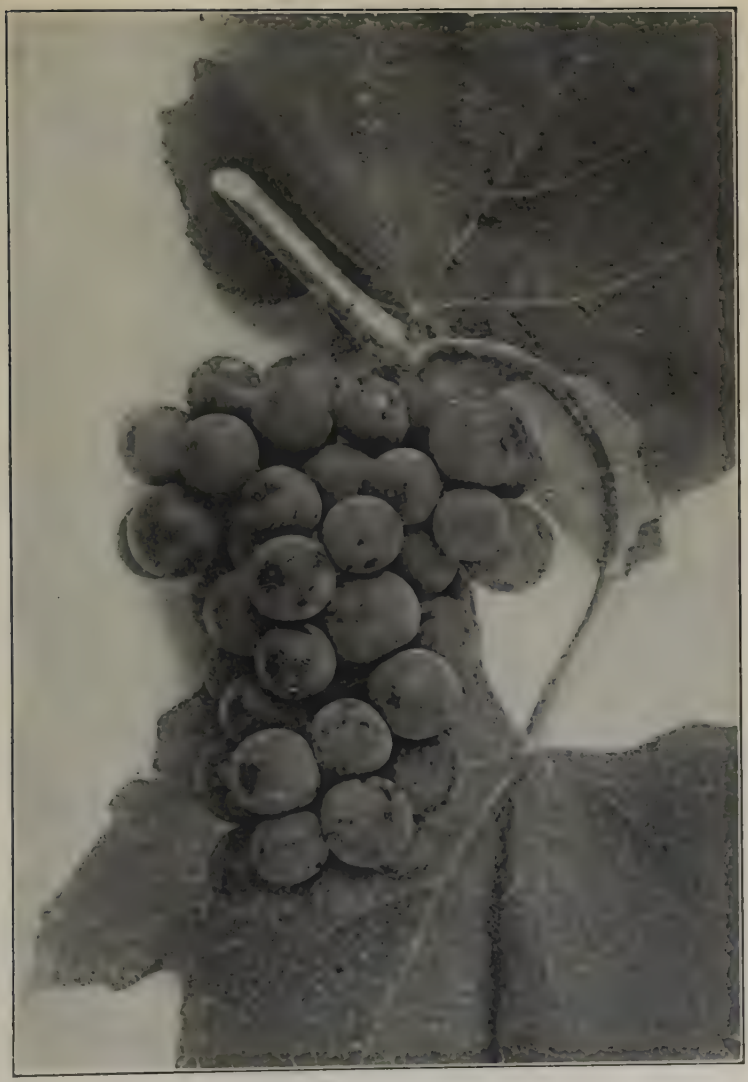

PLATE XV. — Eclipse ($\times \frac{2}{3}$).

than we have done in the past and by using them produce better hybrid sorts.

Varieties.

From the eighty-five varieties of European grapes now fruiting on the grounds of the New York Agricultural Experiment Station, the following are named as worth trying in the East for table grapes: Actoni, Bakator, Chasselas Golden, Chasselas Rose, Feher Szagos, Gray Pinot, Lignan Blanc, Malvasia, Muscat Hamburg, Palomino and Rosaki. These and other European grapes are described in Chapter XVIII; Chasselas Golden and Malvasia are illustrated in Plate V.

CHAPTER XI

GRAPES UNDER GLASS

GRAPE-GROWING under glass is on the decline in America. Forty or fifty years ago the industry was a considerable one, grapes being rather commonly grown near all large cities for the market, and nearly every large estate possessing a range of glass had a grapery. But grapes are better and more cheaply grown in Europe than in America, and the advent of quick transportation permits English, French and Belgian grape-growers to send their wares to American markets more cheaply than they can be grown at home. For the present, the world war has stopped the importation of luxuries from Europe, and American gardeners ought to find the culture of grapes under glass profitable; they may expect also to be able to hold the markets for many years to come because of the destruction of Belgian houses and the shortage of labor in Europe resulting from the war.

Amateur gardeners ought never to let the culture of grapes under glass wane, since the hot-house grape is the consummation of the gardener's skill. Certainly the forcing of no other fruit yields such generous rewards. Grapes grown under glass are handsomer in appearance and better in quality than those grown out-of-doors. The clusters often attain enormous size, a weight of twenty to thirty pounds being not uncommon. The impression prevails that to grow grapes under glass, one must have expensive houses; this is not necessary, and "hot-house grapes" is a misnomer, the fruit really being grown in

cold or relatively cool houses which need not be expensive. Grapes are grown under glass with greater ease and certainty than is imagined by those who form the opinion from buying the fruit at high prices in delicatessen stores. A grapery need not be an expensive luxury, and the culture of grapes under glass can be recommended to persons of moderate means who are looking for a horticultural hobby.

The Grapery

Almost any of the various modifications of greenhouses can be adapted to growing grapes. Firms constructing greenhouses usually have had experience in building graperies, and, as a rule, it will pay to have these professional builders put up the house. If the actual work is not done by a builder, it is possible to purchase plans and estimates, from which, if sufficiently detailed, local builders can work. On small places there is no doubt that the lean-to houses are most suitable, being inexpensive and furnishing protection from prevailing winds. These lean-tos should face the south and may be built against the stable, garage or other building; or better, a brick or stone wall to the north may be erected. It is possible to build a small grapery as a lean-to out of hot-house sash.

In commercial establishments and for large estates, where the grapery must be more or less ornamental, a span-roof house is rather better adapted to the grapery than a lean-to, especially if the house is not to be used for the production of grapes early in the season. On account of the exposure of the span-roof house on all sides, however, rather more skill must be exercised in growing grapes in them than in the better protected lean-to grapery. Whatever the house, it must be so constructed as to furnish an abundance of light, a requisite in which much is gained by having large-size glasses for the glazing. The glass must be of the best quality, otherwise the foliage and fruit

may be blistered by the sun's rays being focused through defective spots.

Light, heat, moisture and good ventilation are all required in the grapery. Brick or stone are preferable to woodwork, as heat and moisture in the grapery are quickly destructive to wood foundations. If wood is used, only the most durable kinds should enter into the construction of the house. The under structure of masonry or of wood should be low, not higher than 18 inches or 2 feet before the superstructure of glass begins. The grapery must be well ventilated. There must be large ventilators at the peak of the house and small ones just above the foundation walls or in the foundation walls themselves. The ventilation should be such that the house can be kept free from draughts or sudden changes of temperature, as the grape under glass is a sensitive plant, and subject to mildew. Plenty of air, therefore, is an absolute necessity to the grapes, especially during the ripening of the fruit. The lower ventilators in graperies are seldom much used until the grapes begin to color, at which time the new growth, foliage and fruit are hardened, but from this time on upper and lower ventilators must be so manipulated that the houses are always generously aired.

Grapes can be forced in cold houses without the aid of artificial heat and formerly these cold graperies were very popular; but in the modern houses for growing this fruit, artificial heat is now considered a necessity, even though the heating apparatus may seldom be in use. For a finely finished product, a little heat to warm the room and dry the atmosphere may be absolutely necessary at a critical time, this often saving a house of grapes. Of heating apparatus, little need be said. Standard boilers for heating greenhouses with either steam or hot water are now to be purchased of many designs for almost every style and condition of house. Since the grapery seldom requires high heat, hot water is rather to be preferred to steam,

although there is no objection to steam, especially if the grapery is a part of a large range of glass.

The border.

The border in which the vines are to be planted is the most important part of the grapery. All subsequent efforts fail if the border lacks in two imperatives, good drainage and a soil that is rich but not too rich. The grapery must be built on well-drained land or elevated above the ground to permit the construction of a properly drained border. "Border," in the sense of its being a strip or a narrow bed just inside the house, is now a misnomer, though the name undoubtedly comes from the fact that narrow beds inside the house were at one time used in which to plant vines. The border in a modern grapery now occupies all of the ground surface inside the house and may extend several feet outside the house.

Much skill is required in building the border. A good formula is: Six parts loamy turf from an old pasture; one part of well-rotted cow manure; one part of old plaster and one part of ground bone. These ingredients are composted and if the work is well done will meet very well the soil and food requirements of the grape. This formula can be varied according to soil conditions and somewhat in accordance with the variety planted. Unless natural drainage is well-nigh perfect, the border must be under-drained with tile and in any case a layer of old brick or stone is needful to make certain that the drainage is perfect. At least two feet, better three feet, of the border compost should be placed above the drainage material. In a border made as described, the grape finds ample root-run, but not too much, as in a surprisingly short time roots are found throughout all parts of this extensive border.

The care of the border is a matter of considerable moment and varies, of course, with those in charge. The usual procedure is to spade the outside border, if the border extends outside,

before winter, after which it is covered with a coating of well-rotted manure, without any particular attempt having been made to keep out the frost, as a certain amount of freezing outside of the house is held to be beneficial. The inside border must be spaded just before the vines are started in the spring, having been covered previously with well-rotted manure. The time at which the vines are to be started in growth is determined by whether an early or a late crop of grapes is wanted. For an early crop, the vines must be started early in February; for a late crop, a month or even two months later suffices. So started, the first crop of grapes comes on in June or July, the later ones following in August or September.

It is related that Napoleon I, to secure saltpetre for making gunpowder, composted "filth, dead animals, urine and offal with alternate layers of turf and lime mortar," and asserted that "a nitre-bed is the very pattern of a vine-border" and that "when the materials have been turned over and over again for a year or two they are in exactly the proper state to yield either gunpowder or grapes." Napoleon's niter-bed is not now considered a good model for a grape-border, as the fruit produced in so rich a soil, though abundant, is coarse and poorly flavored, and the vines complete their own destruction by over-bearing. Gardeners hold that a grape-border may be too rich in plant-food, especially too rich in nitrogen.

Varieties

Out of the 2000 or more Vinifera grapes, probably not more than a score are grown under glass, and of these but a half dozen are commonly grown. Black varieties have the preference for indoors, especially if grown for the market, where they bring the highest prices. They are also as a rule more easily handled indoors than the white sorts. However, as we

shall see, one or two white kinds are indispensable in a house of any considerable size.

Of black grapes, Black Hamburg carries the palm of merit because it is most easily grown, best stands neglect, is a heavy producer, sets its fruit well, the grapes mature early; and, in particular, it meets the requirements of the unskilled gardener better than any other grape. The clusters are not as large and the flavor not as good as that of some other sorts.

Muscat of Alexandria is the best of the white varieties. It is, however, a hard grape to handle since it requires a high temperature to bring it to perfection, is a little shy in setting fruit and the grapes are not very certain in coming to maturity; it also requires a long season. A good quality is that it may be kept long after cutting, much longer than Black Hamburg.

For an earlier white grape, Buckland Sweetwater has much to recommend it; it ripens from two to three weeks earlier than Muscat of Alexandria and is much more easily grown. It is good in quality but not of high quality. Buckland Sweetwater may be well grown in the house with Black Hamburg, whereas it is almost impossible to grow Muscat of Alexandria in the same house with Black Hamburg.

Muscat Hamburg is a cross between Black Hamburg and Muscat of Alexandria, and is an intermediate in most fruit characters between these two standard sorts. It is not, however, very generally grown, although it well deserves to be because of its large, beautiful, tapering clusters of black grapes of finest quality.

Grizzly Frontignan adds novelty to luxury in the list of indoor grapes. The fruits are mottled pink in color, deepening sometimes to a dark shade of pink, and are borne in long, slender clusters. The grapes ripen early and are unsurpassed in quality but are, all in all, rather difficult to grow.

Barbarossa and Gros Colman are the two best late black grapes, especially for those who are ambitious to grow clusters

of large size with large berries. Both are very good in quality. Neither of the two is particularly easy to grow, since they require a long time to ripen; but, to offset this, both keep longer than any other sorts after ripening. Because of the large size of the berries, thinning must begin early and must be rather more severe than with other grapes. This variety is now largely grown in England for exportation to this country in early spring.

White Nice and Syrian are two white sorts which attain largest size in clusters, specimens weighing thirty pounds being not infrequent, but are coarse and poor in quality and are, therefore, hardly worth growing.

Alicante is a black sort often grown for the sake of variety, since it departs from the Vinifera type rather markedly in flavor. The grapes have very thick skins and may be kept longer than those of any other variety.

Lady Downs is another late-keeping black grape of highest quality, but difficult to grow. The bunches and berries are small in comparison with other standard sorts, characters that do not commend the variety to most gardeners.

Perhaps a dozen more sorts might be named worthy of trial in American graperies, but the list given covers the needs of commercial establishments and will meet the wants of most amateur growers.

Planting and Training

Two-year-old vines are most commonly planted. The vines are set inside the house at least a foot from the walls and four feet apart. The grapery must be built on piers with spaces of at least two feet between, and the vines are placed opposite these openings in the foundation. When planted, the vines are cut back to two or three buds, and when these start the strongest are selected for training, the others being rubbed off.

The grapery must be strung with wires running lengthwise of the house at about fifteen inches from the glass. Greenhouse supply merchants furnish at a low price cast iron brackets to be fastened to the rafters to hold these wires. As the growing vines reach one wire after another, they are tied with raffia to hold them in place. Usually, young vines will reach the peak of the house by midsummer, and as soon as this goal is attained must be pinched so that the cane may thicken up and store food in the lateral buds for the coming season. When the wood is well matured, the vine is cut back to half or one-third its length, depending on the variety, laid on the ground and covered for the winter. An item of no small importance in winter care is to keep out mice, this pest being inordinately fond of grape buds, and once the buds are destroyed the vines are ruined for the coming season.

The second year's work is largely a repetition of that of the first. The vines are permitted to reach the peak of the house and are again stopped by pinching. A considerable number of laterals spring up on each side of the main vine, and these must be thinned as they develop to stand at the distance apart of the wires to which they are fastened. This is pre-supposing that the gardener has chosen the spur method of pruning, the method generally used in America and the one, all things considered, which gives best results. The selection of the laterals the second year, therefore, is a matter of much importance since spurs are to be developed from them. Care should be taken to have these spurs regularly distributed over the length of the vine. This second year, grapes must not be permitted to develop on the terminal shoots, but a few clusters may be taken from the laterals in which case the laterals are pinched two buds beyond the cluster, the pinching continuing throughout the season if the laterals persist in breaking, as they will do in most cases. At the end of the season, the terminal is shortened at least one-half, and the laterals are pinched back

to a bud as close as possible to the main stem. The vines are then put down for the winter as at the close of the first season.

The work of the third season is a repetition of that of the second, with the exception that the vine is permitted to fruit throughout its whole length, although not more than one pound of fruit to a foot of main vine is permitted. The plants are now established and the only pruning in this and succeeding years is to cut the laterals at the close of each season close to the main stem, leaving strong healthy buds of which at least one, usually more, will be found close to the stem. If more than one bud starts, only the strongest is chosen, although often an extra one is needed to fill a vacancy on the opposite side. After the third or fourth season, depending somewhat on the variety, two pounds of fruit or more to the foot of the main stem can be permitted. The novice, however, is likely to permit his vines to overbear with the result that the crop is cast, or the berries rattle, or the fruit turns sour before ripening. From the beginning to the finish of the season, in this method of pruning, much pinching of laterals is required. No hard and fast rule can be laid down for this pinching, but, roughly speaking, all new growth beyond the second joint from the cluster should be pinched out as fast as it shows. With most varieties, this means that the lateral is kept about eighteen inches from the main stem. After a few years, well-developed spurs form at the base of the original laterals, and from these spurs the new wood comes year after year.

An alternative method of pruning is to permit the new canes to grow up from a bud near the ground each season. When the vine is well established, this new cane is fruited throughout its entire length, the laterals being pinched as described under the spur method. This method of pruning is known as "the long cane method." Gardeners hold that they can grow better fruit with this than with the spur method, but the difficulties are greater and the crop is not as large.

Care of the Vines

With the cultivation of all varieties indoors, more clusters set than the vines can carry. This means that a part of the clusters must be removed, an operation that depends on the variety and one that requires experience and judgment on the part of the gardener. Roughly speaking, half the clusters are taken, leaving the other half as evenly distributed on each side of the vine as possible. The time to take these clusters is also a delicate matter, since some sorts are shy in setting and the clusters must not be taken until the berries are formed and it can be seen how large the crop will be. As a rule, however, this thinning of clusters may be begun as soon as the form of the cluster can be seen.

It is very necessary also, especially with all sorts bearing large berries, that grapes be thinned in the cluster. The time to thin the cluster varies with the variety. Sorts which set fruit freely can be thinned sooner than those which are shy in setting. On the one hand, the thinning must not be done too soon as it cannot be told until the berries are of fair size which have set seed and which have not; however, if thinning is neglected too long, the berries become over-crowded and the task becomes difficult. The thinning is performed with slender scissors, and the bunches must not be touched with the hand, as touching impairs the bloom and disfigures the fruit. The clusters are turned and steadied by a small piece of pencil-shaped wood. Thinning is practiced not only to permit the berries to attain their full size but also to permit the bunches to attain as great size as possible. If too severely thinned, the clusters flatten out after maturity. This is especially the case when too many berries are taken from the center of the bunch. A large cluster of grapes is made up of several small clusters, making it necessary to tie up the upper clusters or shoulders of the bunch to permit the berries to swell without

being thinned too severely. Grapes intended for long keeping require more thinning than those to be used at once after picking, since, in keeping, the berries mold or damp-off in the center of the bunch if it is too compact.

The vines in the grapery must be watered with considerable care. The amount of water to be used depends on the composition of the borders and the season of growth. If the border is loose and well-drained, the supply of water must be large; if close and retentive, but a small amount of moisture is required. Watering must not be done during the period of blossoming, since dry air is necessary for proper pollination. When the grapes begin to show color, the vines are heavily watered, after which little if any water is applied. Some gardeners mulch the vines with hay to retain the moisture in the house and keep the atmosphere dry.

Ventilating the grapery is another important detail of the season's work. Proper ventilation is difficult to secure in the early spring months when the dryness of the sun on the one hand, and cold air on the other, make it difficult to avoid draughts and regulate the temperature. Another troublesome time is when the grapes begin to color, as it is then necessary for the grapery to have air at night; but when too much air enters, there is danger from mildew. Towards the end of the season, all parts of the plant become harder in texture and the grapery may then be more generously aired. After the fruit is cut, the houses are ventilated in full so that the wood may ripen properly.

Pests

Several pests vex the gardener in growing grapes indoors. Of these, mealy-bug, red-spider, thrips and mildew are most troublesome. In a well-conducted grapery, there is never an intermission in the warfare against these pests.

Mealy-bug is usually a sign of sloth on the part of the gar-

PLATE XVI. — Elvira ($\times\frac{2}{3}$).

dener. In a grapery devoted exclusively to grape-growing, it should never be seen, but, since gardeners must often grow other plants in the grapery, mealy-bug sooner or later appears and is often hard to dislodge. It is best repelled by removing the loose bark on the trunks which harbor the pest and then washing with kerosene emulsion. When this becomes necessary, not only the vines but the rafters and all parts of the house should be sprayed with the emulsion.

Red-spider is another pest usually found in the grapery, but it thrives only in a dry atmosphere and is easily gotten rid of by syringing. As soon as red-spider appears in a house its appearance is usually known by the reddish tinge on the foliage; syringing should be kept up until the pest is disposed of, keeping the house damp in all except dull weather. Syringing is done only when plenty of air can be given and when it can be followed by sunlight so that the water remains on the vines as short a time as possible.

Thrips, another small insect, is sometimes troublesome but not often and is now easily controlled by applications of nicotine. Much care must be taken in the application of nicotine late in the season, otherwise the fruit will be injured.

The only fungous disease of the grape troublesome in the greenhouse is mildew. Mildew is usually brought on by a sudden change of temperature or by draughts in the grapery. Gardeners are of the opinion that east winds, in particular, give unfavorable conditions for mildew and prefer to open the ventilators to the west. If taken in time, mildew is easily kept in check by preventing the conditions which favor it, and by dusting the vines in dry sunshine with sulfur.

CHAPTER XII

GRAPE PESTS AND THEIR CONTROL

In common with other cultivated fruits, grapes are at the mercy of numerous insect and fungous pests unless man intervenes with remedial or preventive treatment. Happily for viticulture, knowledge of the pests of the vine has made such advancement in recent years that practically all are now controlled by remedial or preventive measures. Possibly no field of agriculture has had greater need, or received greater aid from science in the study and control of insects and diseases than grape-growing. A separate treatise would be required to treat the pathological troubles of the grape fully; only such details of the life histories of the several pests to be discussed as are essential to a proper understanding of the control of the parasites can be given here.

Insect Pests

Insects troubling the grapes are numerous, at least 200 having been described in America, most of which have their habitat on the wild prototypes of the cultivated vines of this continent. For this reason, with a few exceptions, the insect pests of the grape in America are widely distributed, abundant, and, therefore, often very destructive to vineyards unless vigorously combated. The many pestiferous species vary greatly in importance, depending on locality, weather and the variety. Phylloxera, however, the country over, is most common and deserves first attention.

Phylloxera.

This minute sucking insect (*Phylloxera vastatrix*), injures the grape by feeding on its roots. Decay usually follows its work on the roots and is often more injurious than the harm done directly by the parasite. This decay is always much more serious on European vines than on those of our native species. The phylloxera is a native of the United States east of the Rocky Mountains, from whence it was introduced into France and from France into California, where it causes much greater damage than elsewhere in the United States. Wherever the pest is found, it is more injurious in heavy than in sandy soils. In fact, in very sandy soils the vines are often sufficiently resistant to be practically immune.

Fig. 36. Leaf-galls of the phylloxera.

The life history of the phylloxera is very complex where the different forms of the insect appear and need not be entered into in detail here. East of the Rockies, the most evident indication of the presence of the pest is great numbers of leaf-galls on the under side of the leaves of the grape as shown in Fig. 36. These galls, however, are seldom to be seen in California and are not present on Concords and some other varieties in the East. The winter egg may be taken as the beginning of the life cycle of the phylloxera. From a single winter egg a colony may arise, the

first insect after hatching making its way to the leaves where it becomes a gall-maker and gives rise to a new generation of egg-laying root-feeders. On varieties and in regions where the gall form is not found, the insect probably goes directly from the winter egg to the roots. Once the pest is established on the roots, generation follows generation throughout the growing period of the vines, as many as seven or eight occurring in one season.

From midsummer until the close of the growing season, some of the eggs deposited by the root-feeders develop into nymphs which acquire wings and emerge from the soil to form new colonies from eggs deposited on the under side of the leaf. An individual insect deposits from three to six eggs of two sizes, from the larger of which come the females and these, after fertilization, move to the rough bark of the vine and deposit the winter egg for the renewal of the cycle.

Several methods of control have been employed in Europe and California, as treatment by carbon bisulfide injected in the soil; flooding in vineyards that can be irrigated; confining the vines to sandy soils; and, most important, planting vines grafted on resistant stocks, there being great variation in immunity of species of American grapes to phylloxera. The subject of stocks resistant to this pest has been discussed in Chapter IV and need not be taken up again. East of the Rockies, treatment is not necessary with American grapes.

The grape root-worm.

The grape root-worm is the most harmful of the insect pests of grapes in the grape-belt along the shores of Lake Erie in Ohio, Pennsylvania and New York. This root-worm (Fig. 37) is the larva of a grayish-brown beetle (*Fidia viticida*), shown in Fig. 38. The worms feed at first on the rootlets and later on the bark of the larger roots of the vines so that the injured plants show roots de-

void of rootlets and bark channeled by the pest. So plain is the work of the root-worm that the grower never need be at a loss as to the cause of vines injured by this pest. The worms feed during the latter part of the growing season, reaching full growth at this time. The next June they transform into pupæ and in late June or early July emerge as adult beetles.

FIG. 37. The grape root-worm.

FIG. 38. Root-worm beetle.

The presence of the adult beetles is more easily detected on the foliage than is that of the larvæ on the roots, for the feeding beetles ravenously devour the upper sides of the leaves, leaving chain-like markings, shown in Fig. 39, their destructiveness decreasing somewhat after a few days from their first appearance. A fortnight after the beetles begin their attack on the foliage the female begins laying her eggs, to the number of 200, placing them under the rough bark of trunk and cane. These hatch in late July or August and the young grubs at once seek the roots.

Two methods of control have been devised: destruction of the beetles before they lay their eggs; and de-

FIG. 39. Injuries caused by beetles of the grape root-worm.

struction of the pupæ while in the ground. When the beetles are present in large numbers, many of them may be destroyed by spraying with a mixture of cheap molasses and arsenate of lead, using molasses at the rate of two gallons to a hundred gallons of water and the arsenate of lead at the rate of six pounds. This should be followed by a second spraying a week later, using bordeaux mixture (4–4–50) and three pounds of arsenate of lead. This second spray serves to repel migrating beetles from the vines. The molasses spray is ineffective unless several days of fair weather follow the spraying, as rain washes the material from the foliage. Bordeaux mixture is not easily affected by rain. In moderately infested vineyards, bordeaux mixture and arsenate are used instead of molasses and arsenate of lead, followed in about ten days with a second application of the same material.

An effective method of reducing the number of beetles is the destruction of the pupæ. This is best done by leaving a low ridge of earth under the vines at the last seasonal cultivation to remain until most of the larvæ have pupated, and then be leveled with a horse-hoe and later with a harrow. The horse-hoe and harrow crush many of the pupæ and break the cells of others to the great destruction of the pest. This latter method of control is not adequate in itself and in bad infestations both should be used. When the infestation is only moderate, this latter method is not advised, owing to the lateness of the time of horse-hoeing. It is good horticultural practice to horse-hoe the latter part of May or early June. To wait for the pupal stage of the root-worm delays the work until numerous small roots start which would be destroyed by the horse-hoe. Spraying will control a moderate infestation.

The grape-vine flea-beetle.

In the warm days of May and June when the buds of grapes are swelling, a shining steel-blue beetle may often be found in

the vineyards of eastern America feeding on the tender buds of the grape. From its color the insect is often called the steely-beetle, and from its activity and habit of jumping it is known as the flea-beetle (*Haltica chalybea*). The vine is seldom seriously injured by this pest but many buds are destroyed, causing the loss of the fruit that should have developed from the buds. It is true that new buds often develop after the injury, but these, as a rule, produce only foliage.

FIG. 40. Eggs of grape-vine flea-beetle.

The life history of the flea-beetle is such that the pest is not hard to control, the chief steps in its development being as follows: The beetles deposit small orange-colored eggs, cylindrical in form, illustrated in Fig. 40, about the buds and in crevices of the bark of the canes in May or June. Most of these eggs are hatched by the middle of June. The larvæ feed upon the foliage until about July first and then crawl to the ground in which they form cells and pupate. The latter part of July the adults emerge and seek wild vines upon which they feed, entering hibernation rather early in the fall. The beetles hibernate under leaves, in rubbish and in the shelter of the bark of trees and vines, but emerge in the warm days the following spring to seek vineyards.

Two methods of control have been developed to keep this pest under. The vines should be sprayed with three pounds of arsenate of lead in fifty gallons of water when the larvæ are feeding on the foliage; or the beetles when feeding may be knocked into a pan containing a shallow layer of kerosene. The former is the cheaper and more effective method provided the grape-grower has the foresight to discover the larvæ, since the larvæ of this summer produce the beetles that will destroy

the buds next spring. When the adults migrate from wild vines, or the larvæ were not destroyed in the vineyard, collecting the adults is the only practical method. The destruction of wild vines near a vineyard helps to give immunity from this pest.

The rose-chafer.

The rose-chafer (*Macrodactylus subspinosus*), a long-legged beetle of a yellowish-brown color, about a third of an inch in length, often appears in vineyards in vast swarms toward the middle of June in northern states and about two weeks earlier in southern states east of the Rocky Mountains. Often they overrun gardens, orchards, vineyards and nurseries, and usually, after having done a vast amount of damage in the month of their devastating presence, the beetles disappear as suddenly as they came. Vineyards on or near sandy soils are most often infested, the larvæ of the beetle seeming to live in considerable numbers only in these light soils. The chief damage to the grape is done to the blossom; in fact the insects, after feeding on the blossoms during the blossoming period, usually migrate to blossoms of any one of several shrubs. The larvæ feed on the roots of grasses, having particular liking for the roots of foxtail, timothy and blue-grass.

Some knowledge of the life history of these beetles is essential to effective control. The beetles emerge as adults in June and after feeding a short time begin to mate, although egg-laying does not take place until the insects have been out for a fortnight or more. The females burrow into the soil and deposit their eggs, seldom more than twenty-five in number, which begin to hatch in about ten days. The young larvæ feed during the remainder of the summer on roots of grasses. They are seldom found deeper than six inches while feeding, but as cold weather approaches they burrow deeper to avoid sudden changes of temperature. The following spring they

again come near the surface to feed. The grubs form cells from which the pupæ emerge, as we have seen, about the middle of June, timing their appearance very closely to the blossoming of Concord grapes.

The methods of control are three, namely: destruction of the larvæ; cultivation to kill the pupæ; and spraying to kill the beetles. Since the larvæ feed on the roots of grasses in sandy soils, it is easy to locate the feeding ground of the pest and plant it to cultivated crops which destroy the grasses and therefore the larvæ. The second method of destruction is similar, consisting of cultivation to kill the pupæ. This is accomplished by thorough cultivation during the pupating stage to break the cells and crush the pupæ, thus preventing the emergence of the beetles. The third method, however, is the most effective and consists of spraying the vineyard with a sweetened arsenical spray. The spraying should be done as soon as the beetles appear, using arsenate of lead six pounds, molasses one gallon and water one hundred gallons. It is often necessary to make a second application a week later. If rain occurs within thirty-six hours after spraying, the application should be repeated as soon as the weather clears.

The grape leaf-hopper.

From Canada to the Gulf and from the Atlantic to the Pacific, wherever the grape is grown, the small leaf-hopper (*Typhlocyba comes*) infests the grape in greater or less numbers, feeding on the lower surface of the leaf. Grape-growers commonly call these insects "thrips," a name, however, which really belongs to a very different class of insects. The injury done by this pest varies greatly with the season and the locality, in some regions it being comparatively harmless and in others exceedingly destructive in seasons when it occurs in abundance. There is great variation also in individual vineyards, those near favorable hibernating places and early spring food plants

often being injured seriously season after season in succession. These leaf-hoppers obtain their food by piercing the epidermis on the under side of the leaf surface and sucking the sap, and add further injury by inserting their eggs underneath the skin of the leaf. The punctures greatly decrease the starch-producing area of the leaf with the result that the vigor of the plant is lowered, and the quality of the fruit decreased.

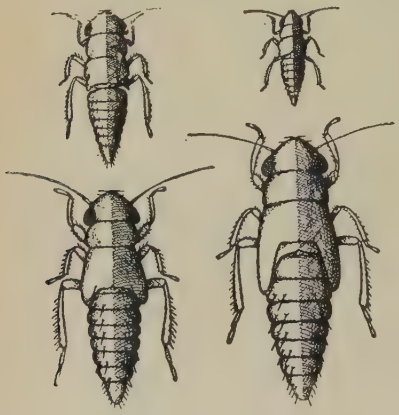

FIG. 41. First four stages of the grape leaf-hopper. (Enlarged.)

The life history of the leaf-hopper is very well known. The eggs are deposited in June or early July, and hatch from June 15 to July 10 in New York, the season being earlier or later as one goes south or north. The young leaf-hoppers are wingless, the nymph stage, but reach the adult stage in late July and August, at which time many of them mate, and eggs are laid from which a second brood may develop, although usually only one full brood is produced in a season in the northern states. Figures 41 and 42 show the several life stages of the leaf-hopper. Insects which become adults in the latter

FIG. 42. The fifth and the mature stages of the grape leaf-hopper. (Enlarged.)

part of July feed on the foliage until autumn and then seek winter quarters, passing the winter in the adult stage under fallen leaves, in dead grass or other similar protection. The hibernating place must be dry and for this reason sandy knolls are most favored by the insects. The adults emerge in the warm days of spring and then seek food first on the strawberry, then migrate to red and black raspberries or blackberries, if raspberries are not present. They remain upon these hosts until the grape leaves expand and then migrate to these to feed, lay their eggs and die.

Three methods of control are in use to prevent the ravages of the leaf-hopper: avoiding the planting of raspberries near grapes; spraying with contact insecticides; and the destruction of hibernating places. Since the leaf-hoppers feed especially on the raspberry before the leaves of the grape have expanded in the spring, avoiding planting these two plants near each other is a very effective method of control. The contact spray must touch the body of the insect and must, therefore, be applied before the nymphs develop wings. The best spray is a half pint of Black Leaf 40 to a hundred gallons of water or bordeaux mixture. It is applied to the under side of the foliage by a trailing hose or by an automatic grape leaf-hopper spray devised by F. Z. Hartzell and described in bulletin 344 of the New York Experiment Station. The destruction of hibernating places is almost as effective a method of control as spraying. All weeds and strong-stalked grasses which die in the fall and all rubbish in the vineyard should be destroyed. It is quite worth while, also, to burn leaves and rubbish in fence rows and waste places near infested vineyards in the autumn or early winter. Cover-crops which remain green during the winter do not harbor the leaf-hoppers.

The grape-berry moth.

This pest is widely distributed, attacking the grape wherever grown in North America. The insect feeds on all varieties

but is especially destructive to grapes with tender skins and such as grow in compact bunches. Its work is detected usually in compact grape clusters where a number of berries are injured by a "worm." The "worm" is a dark-colored caterpillar, the larva of the grape-berry moth (*Polychrosis viteana.*) There are two broods of this caterpillar, the first of which feeds on the stems and external portions of the young berries, while the second attacks the berries. The loss to the fruit-grower is of two kinds, the loss of the fruit and the marring of clusters which entails the cost of picking out worthless berries. Figure 43 shows the work of the grape-berry moth. The damage is usually greatest near woodlands since the trees cause more snow to lodge in the adjoining vineyards, this protection permitting a greater percentage of pupæ to survive.

FIG. 43. A bunch of grapes despoiled by the grape-berry moth.

The moth passes the winter in the pupal state on leaves underneath the vine, emerging about the time grapes are blossoming. The sexes then mate and the eggs are laid on the stems, blossom clusters and newly set fruit. After reaching full growth, the caterpillars cut out a portion of the leaf from which they make a pupal case by means of silken threads, and here pupate for the second brood which emerges in late July and August. Eggs are laid at once and from these come the caterpillars which live entirely in the berry. The larvæ leave the berries about the time the fruit is

ripe, form cocoons on the leaves and hibernate. The moths are small, brown in color, mottled with gray and so much the color of the grape cane that they can hardly be detected when resting on the wood.

The grape-berry moth is difficult to control but much can be done to curtail its ravages. Spraying after the fruit sets is the most effective preventive. Bordeaux mixture should be used (4–4–50) to which has been added one and one-half pounds of resin-fish-oil soap and three pounds arsenate of lead. A second application of the same spray is advisable in early August. In a small vineyard or with a slight infestation, it often pays to pick and destroy the berries infested by the spring brood. Plowing infested vineyards in late fall or early spring to bury all leaves prevents the emergence of many of the moths. To be effective, this practice must cover the leaves deeply directly under the vines and this earth must remain until after the time for the adults to emerge. Plowing under leaves is not as effective on sandy as on heavy soils, since sandy soils do not become sufficiently compact to prevent the escape of moths.

Insect pests of minor importance.

Of the 200 species of insects that feed more or less on the grape, entomologists mention several others than those described that in occasional years or localities become abundant and cause serious injury. Thus, there are several species of cut-worms which sometimes feed on the expanding buds of the young leaves of grapes. The damage of these cut-worms to the grape is greater in California than in other parts of the United States, but nevertheless they occasionally feed on the vines in eastern regions to the detriment of the crop. The most satisfactory control measure for cut-worms is the application of poisoned bait placed on the ground at the base of the vines.

In California there is a grape root-worm (*Adoxus obscurus*) quite distinct from the grape root-worm of eastern America which injures both the roots and the parts of the vine above ground. As in the eastern species, the best evidence of infestation of this pest is the narrow chain-like strips eaten out of the leaves, though the insect also gouges out part of the petioles, pedicels, berries and shoots and works under ground, eating the rootlets and bark of the larger roots. Infested vines show a stunted condition, the canes fail to attain a normal growth and often the vines are killed outright. As in the case of the eastern species, this root-worm is the larva of a beetle, the life history of the insect not being greatly different from that of the eastern beetle. Two methods of control are fairly effective: the adult beetles may be jarred from the vine and captured on a screen when the infestation is restricted to small areas; or the beetles may be poisoned with the arsenical spray recommended for the eastern species. Both jarring and spraying often have to be repeated as new infestations appear.

The grape leaf-folder (*Desmia funeralis*) is another insect pest of vineyards in California, and occasionally in the East, which works, however, only in restricted localities and in occasional years. In California, the insects are detected in a vineyard by the characteristic rolling of the leaves in which a tube rather less than the diameter of a lead pencil is formed for the home of the larvæ. The larvæ feed on the free edge of the leaf in the interior of the roll and are thus protected by the outer layers. In the East the caterpillar merely folds the edges of the leaves together. This leaf-folder hibernates as a chrysalis, coming forth in early spring to lay eggs on the vine shortly after the foliage has appeared. There are two broods in California and the northern states and three broods in the southern states. The leaf-folder is easily disposed of by spraying with an arsenical spray just after the eggs hatch and before the larva is protected by its roll of leaves.

Still another pest found throughout the United States and especially destructive in California is the hawk-moth (*Pholus achemon*), the larvæ of which occasionally do serious damage to small areas of vines. These larvæ are very similar to the large worms, familiar to all, which attack the tomato and tobacco. The insect hibernates in the pupal state in the ground where it may be distinguished as a large cylindrical object of dark brown color. The moths emerge about the middle of May and deposit their eggs on the leaves of the grape, upon which the larvæ when hatched immediately begin to feed. There are several species of these hawk-moths, all of which have essentially the same life history. It is not a difficult pest to control since the larvæ are easily killed with arsenical sprays; or if there are but occasional specimens they may be picked by hand. There are several species of the hawk-moth which attack the grape but this is the common one.

In eastern grape-growing regions, there are two other destructive grape insects widely distributed, but each noteworthy as pests only in the Appalachian region of West Virginia and neighboring states. One is the grape-curculio (*Craponius inæqualis*), not essentially different from the familiar curculio of the plum and cherry. This snout-beetle feeds freely on the upper surface of the leaves and the bark of fruit stems, and the female in laying eggs devours the tissues of the grapes in excavating her egg chamber. The grape-curculio is effectively destroyed by spraying with an arsenical spray in the spring as the beetles appear on the vines and before egg-laying begins.

Another insect pest of this region is the grape-vine root-borer (*Memythrus polistiformis*) closely allied to the peach-borer, known by all fruit-growers and the squash-vine borer known to the growers of vegetables. This borer is the larva of a moth and is a whitish grub with a brown head which, when fully grown, is about one and three-quarters inches in length. The body is slender, distinctly segmented and has a sparse

covering of short, stiff hairs. These larvæ burrow into the grape-root, at first confining themselves to the softer portions of the bark, often encircling the root several times, but later bore with the grain of the wood and by the end of the season so destroy the roots as to leave only the thin membrane of the outer bark intact. This pest is difficult to deal with. The borers cannot be removed by "worming" as in the peach, and neither can the roots be protected by sprays or washes. No one variety of the grape seems more immune than another. Thorough cultivation in the months of June and July to destroy the insects while in their cocoons at the surface of the ground seems to be the only method of stopping their ravages, and this is not always effective.

Fungous Diseases of the Grape

The grape is ravaged by four or five fungous diseases in America, unless the utmost vigilance is exercised to keep the parasites in check. Happily for commercial viticulture, there are regions, as we have seen in the description of grape regions in Chapter I, so fortunate in their freedom from fungous diseases that there is little uncertainty in grape-growing and but small expense in controlling diseases. Also modern science has discovered the life history of all the important diseases and devised fairly effective means of combating them.

All of the fungous parasites of the grape in America are indigenous, having long subsisted on wild vines. They are, therefore, all widely distributed, and as cultivation has presented to them great numbers of grape plants in continuous areas, the diseases have increased rapidly in intensity, at times have swept like wildfire through grape regions devastating and utterly ruining great areas of vines. Means, however, are now at hand in remedial and preventive treatment, which, while because of cost may not permit the grapes to be grown profit-

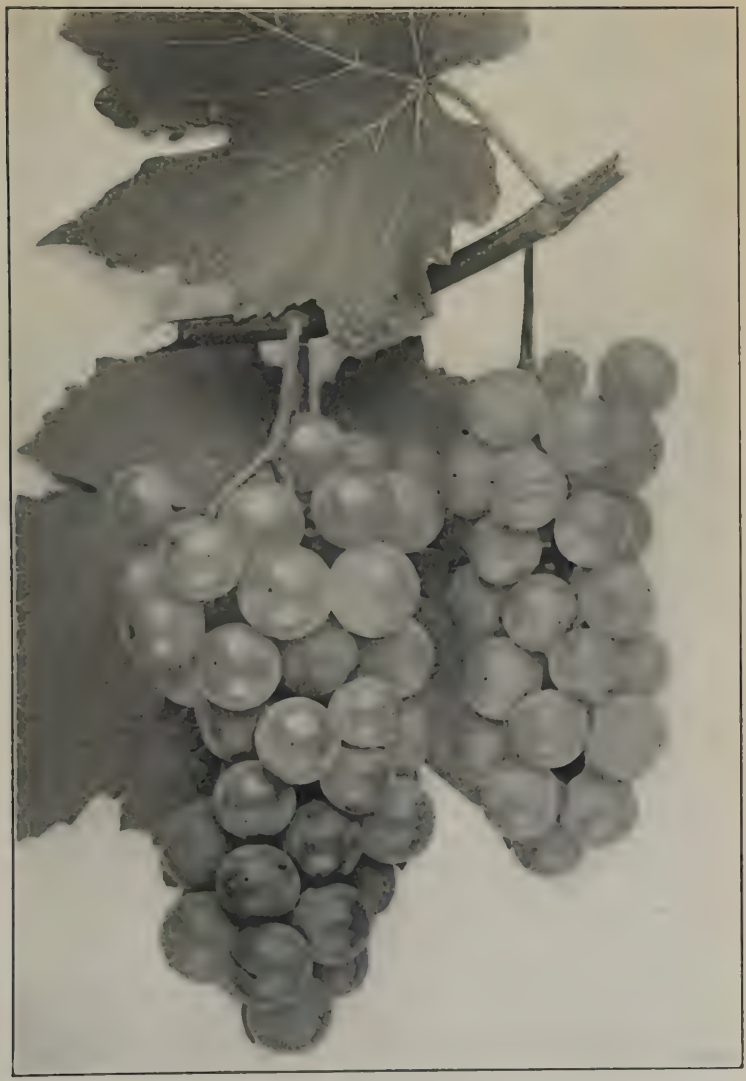

PLATE XVII. — Empire State ($\times \frac{2}{3}$).

ably in all parts of America, do permit their culture for home use in practically all agricultural districts in the country.

Black-rot.

This is the most widely distributed and the most destructive fungous disease of the grape in the region east of the Rocky

FIG. 44. Work of black-rot of the grape.

Mountains. Fortunately, it is unknown on the Pacific coast. The disease is caused by a parasitic fungus (*Guignardia Bidwellii*) which gains entrance to the grape plant by means of minute spores distributed chiefly by wind and rain. Black-rot passes the winter in mummied grapes, on dead tendrils or on small, dead areas on the canes. In the spring, the fungus spreads from these spots to the leaves and forms brown leaf spots about a fourth of an inch in diameter, or oblong, black spots on the shoots, leaves, petioles and tendrils. Later the disease spreads to the fruits, not usually attracting attention

until the berries are at least half grown. Soon after the ravages of the fungus become apparent on the berries, the fruits turn black, shrivel and become covered with minute black pustules which contain the summer-spores. Figure 44 shows the work of black-rot. In the winter and spring, another form called the winter- or resting-spore is produced upon these old, shriveled, mummied berries, and these carry the disease over from one season to another.

Since the disease is carried through the winter in mummied fruits and diseased wood, the desirability of destroying these mummied grapes and the leaves and prunings of infected vines as soon as possible is apparent. This treatment, however, is not sufficient, and the disease can be effectually controlled only by thorough spraying with bordeaux mixture (4–4–50). The first application should be made just before the grape blossoms; the second, shortly after blossoming. The amount of material applied matters less than evenness in distribution and fineness of the spray as applied. In rainy seasons, perhaps a third or a fourth application should be made in regions where the disease is serious; the third is made when the berries are the size of a pea; the fourth, as the berries become large enough to touch each other.

Downy-mildew.

Downy-mildew (*Plasmopara viticola*) rivals black-rot for first place among fungous diseases of the grape. It is found in all grape regions east of the Rocky Mountains but does most harm in northern localities. Like black-rot, downy-mildew attacks all the tender growing parts of the vine, but is chiefly found on the foliage and is usually less destructive than black-rot. As first seen on the foliage, the work of the fungus appears as greenish-yellow, irregular spots upon the upper surface which later become reddish-brown. At the same time on the under surface of the leaf, a thin, white downy growth puts forth.

The spores of the fungus are produced on this downy growth, and under favorable conditions are distributed by wind and water to all tender parts of the vine, where they germinate and begin their work of destruction. The fruit is attacked when partly grown, as shown in Fig. 45, becoming covered

FIG. 45. Grapes attacked by downy-mildew.

with the gray down of the fungus, the "gray-rot" of the grape-grower. If the berries escape the disease until half grown, the fungus causes a brownish-purple spot that soon covers the whole grape, giving the disease at this stage the name of "brown-rot." Besides the summer-spores, another form of reproductive bodies is produced in the winter to carry the fungus through the resting period.

Downy-mildew, like black-rot, spreads most rapidly and

does most injury in hot, wet weather. As with practically all diseases of the grape, much can be accomplished in the way of control of the disease by destroying infested leaves, shoots and berries which contain the winter spores, but these sanitary measures are not sufficiently effective and vineyards must be sprayed as recommended for black-rot, except that the first application should be made before the blossom-buds appear.

Powdery-mildew.

Less troublesome than downy-mildew in the East, powdery-mildew (*Uncinula necator*), unless checked, is capable of destroying the entire crop of European grapes on the Pacific slope. In the East it sometimes causes great loss on the several varieties known as "Rogers hybrids" and, curiously enough, is often a rather serious disease of the Concord. The disease is caused by a superficial fungus which passes the winter on fallen leaves and also on the canes. The spores begin to germinate a few weeks after the grape blossoms, but the disease is not often found until the grapes are nearly half grown. The fine white filaments of the fungus, which constitute the vegetative portion of the parasite, then attack the leaves, shoots and fruit, sending up short irregular branches on which great numbers of spores are borne. These give the upper surface of the leaf a gray, powdery appearance, hence the name. Eventually the diseased leaves become light brown and if the disease is severe, soon fall. Infected berries take on a gray, scurfy appearance, speckled with brown, are checked in growth and often burst on one side, exposing the seeds. The berries, however, do not become soft and shrunken as when attacked by the downy-mildew. The disease passes the winter in resting-spores produced late in the growing season. Powdery-mildew differs from other fungous diseases of the grape in being more prevalent in hot, dry seasons than in cold, wet ones.

In eastern America powdery-mildew is controlled by the

treatment recommended for black-rot. When black-rot is not prevalent, two sprays with bordeaux mixture are recommended; the first in early July and the second about two weeks later. On the Pacific coast, however, powdery-mildew or "oïdium" as it is often called there, the name coming from Europe, is more cheaply and more successfully combated by dusting with flowers of sulfur. Dusting is often done by hand or with perforated cans but this is wasteful and uncertain, and any one of several sulfur-sprayers may be used which does the work better.

Anthracnose.

Another widespread disease is anthracnose (*Sphaceloma ampelinum*), called "birds-eye-rot" because of the peculiar spots produced on the affected fruits, which attacks leaves, shoots and fruits of the vine. It first appears on the leaves in small, irregular, dark brown sunken spots with a dark margin. Later it appears on the fruits, having much the same appearance though the spots are usually larger and more sunken, the disease being most characteristic on the fruit, however. Frequently two or more spots unite and so cover the greater part of the berry. The fruits become hard, more or less wrinkled, and the diseased area often ruptures, exposing the seed, much as with powdery-mildew. The spores of the fungus are produced in great numbers on diseased areas during the growing season and are borne on thread-like filaments which live throughout the winter in the tissues of the vine and are ready for new growth in the spring. Winter-spores have not yet been discovered.

Anthracnose is widely distributed in eastern America but seldom causes great or general loss, most of the commercial grapes being relatively immune to the disease. A few sorts rather commonly grown in home vineyards, as Diamond, Brighton and Agawam, suffer most from anthracnose. Spray-

ing with bordeaux mixture, as recommended for black-rot, is usually sufficient to keep the disease in check.

Dead-arm disease.

A troublesome disease of recent appearance is now doing considerable damage in the Chautauqua grape-belt along the shores of Lake Erie, being most common on the Concord. From the fact that it is usually found on one arm of the vine it is called "dead-arm disease" (*Cryptosporella viticola.*) The disease is caused by a fungus which passes the winter in small, black fruiting bodies in the dead parts of the vine. Early in the spring the fungus spreads by means of spores to the young shoots and later in the season attacks mature berries, producing small, black, oblong spots of black-rot. Sooner or later, if the diseased shoot is not cut off, the fungus spreads to the arms or trunk of the vine, producing a slow, dry rot which eventually kills the affected part. Fortunately, the presence of the disease is quickly detected by small yellowish leaves, much crimped about the margin.

The fungus is easily controlled by marking the diseased arms when the first symptoms appear and cutting these off at pruning time. If the vine is much mutilated by such pruning, usually suckers can be brought up from beneath the surface of the ground to renew the vine. The applications of bordeaux mixture recommended for black-rot are valuable in preventing the dead-arm disease. The disease is largely prevented by renewing the old wood of the vine as soon as the trunk begins to show a gnarled appearance.

Shelling.

In eastern America, especially in the Chautauqua grape-belt, grape-growers not infrequently lose a large part of the crop by the premature falling of the grapes from the stems. The trouble is an ancient one and is designated as "shelling"

or "rattling." This premature dropping usually begins at the end of a cluster, and clusters farthest from the trunk are earliest affected. When vineyards suffer badly from this shelling, the vines often take on a sickly appearance, the foliage falling off in color and the outer margins of the leaves drying up more or less. The fallen fruit has an insipid taste and is, of course, worthless even if it could be harvested.

The cause of the trouble is not known. Grapes may "rattle" on high land or low land, on poor soil or rich soil, on heavy or light soil. A vineyard may be affected one year and not the next. Grape-growers usually attribute the trouble to faulty nutrition, but applications of fertilizers have not proved a preventive. Old and well-established vineyards seem freer from the trouble than new and poorly established plantings. The most reasonable theory as to the cause of shelling is that it comes from faulty nutrition of the vine, but the conditions so affecting the nutrition are not yet satisfactorily determined.

Diseases of minor importance.

Ripe-rot or bitter-rot (*Glomerella rufomaculans*) is a disease due to the same fungus causing the bitter-rot of the apple. As the name indicates, the disease usually appears on the fruit at ripening time and under favorable conditions continues after the grapes are picked. It may also attack the leaves and stems. The first indication of the fungus is the appearance of reddish-brown spots which spread and eventually cover the whole fruit. The berries do not shrivel, but the rotted surface becomes dotted with pustules in which the spores are borne. It is hard to tell how much damage this disease does, but it is not usually great and the late applications of bordeaux mixture for black-rot or powdery-mildew are very effective in controlling it.

Crown-gall, now known to be a bacterial disease which causes knots or galls on the roots of various wild and cultivated plants,

sometimes attacks grape roots or even the vines above ground. Occasionally, the disease is rather serious, but it is not often to be reckoned with in the vineyard regions of America. Fungicides are useless in combating the disease and all that can be done is to exercise great care in planting infected stock. It is doubtful whether crown-gall ever seriously injures vines in northern regions, although it may occasionally do so in the South.

In California there is a somewhat mysterious disease known as "Anaheim disease," because of its having first made its appearance in the vicinity of Anaheim. As near as can be learned, the disease first appeared in 1884 and then spread rapidly from forty to fifty miles from the point where it began its ravages, causing direct and indirect loss of many millions of dollars, and leading to the abandonment of grape-growing in some parts of southern California. Fortunately, in recent years the Anaheim disease is less aggressive but still does more or less damage. The nature and the treatment of this disease are not as yet fully determined, although several experimenters are studying the trouble. Californians whose vineyards suffer from this disease should apply to the experiment station at Berkeley for the latest information in regard to it.

Coulure is another trouble of the vine in California of which little is yet known, either as to cause or treatment. The term signifies the failure of the fruit to set or to remain on the clusters. The trouble occurs in varying degrees from the loss of a few berries to the complete shelling of the fruit from the stem. It is worse in some localities than others and in some varieties than others. Various causes have been assigned to the disease, chief of which, and most probable, are unfavorable climatic conditions.

Control of Insects and Diseases

From the number of insects and diseases found on the grape, it would seem that, literally, "pestilence walketh in darkness

and destruction wasteth at noonday" in the vineyards of the country. But not many of the ills that grape-flesh is heir to are ever found in one region, and the vineyard is seldom attacked by many diseases or insects in a single season. There was a time, as we have said before, when grape-growers were so beset by pests which they could not control, that viticulture was one of the most uncertain fields in agriculture. But one brilliant discovery after another has brought the pests of the grape under the hand of man until now there are but few that need cause much expense in treatment or worry as to the outcome.

Plants cannot be attacked by diseases unless infection is permitted. It follows that by proper sanitation most of the insect pests of the vine can be kept out of the vineyard.

Vineyard sanitation.

By changing or modifying environment, immunity can be secured from many of the pests of the grape and damage may be reduced with most if not all. Cultivation, as has been noted under several insect pests and one or two of the diseases of the grape, is an effective method of eliminating grape pests. In the case of insects, it destroys the insects themselves and the hibernating places as well. The vineyard should never be kept in sod, but always under thorough and frequent cultivation. Vineyard sanitation is greatly improved, also, if cover-crops which remain green during the winter are planted after the last cultivation. Cultivation should usually be preceded by deep plowing in the fall or spring to turn under fallen leaves and weeds or grass in which hibernating insects may pass the winter.

The surroundings of the vineyard should be looked after. Fence-rows and waste lands which cannot be cultivated may often be burned over to destroy the hibernating places of grape insects. As a rule, it is unwise to plant the bramble berries

or even strawberries in vineyards, or adjoining vineyards, since these plants afford hibernating places and food plants for some of the grape insects, especially the destructive leaf-hopper. Lastly, precaution should be taken by destroying all wild grape-vines near vineyards, as these frequently harbor insects and diseases, the flea-beetle finding the wild grape-vine almost a necessity to its existence.

Spraying.

Definite rules cannot be laid down for spraying vineyards the country over. The literature on this subject is plentiful in any state in which grapes are largely grown, within the reach of the grape-grower, and is not difficult to understand once it is in hand. Every grape-grower should secure and study the publications of the state experiment stations having to do with the control of insects and diseases.

The number of applications and the sprays to be used vary greatly in different parts of America. On the Pacific slope the only application yearly required in most vineyard regions is dusting with flowers of sulfur for powdery-mildew. Several other pests may, however, from year to year, or in one locality or another, require special treatment. In the grape regions of New York, many grape-growers do not spray at all, but these are usually slovens or procrastinators whose profits are small and uncertain. In the grape regions of the northeastern states, orderly vineyardists spray at least once with bordeaux mixture (4–4–50) in which is put three pounds of arsenate of lead, no matter how few insects and fungi are present. This treatment is given soon after the blossoms fall. In more southern regions it may be necessary to make a similar treatment soon after the first leaves appear, again after the blossoms fall and every two weeks thereafter until the grapes begin to turn in color, making as many as four, five or even six applications in all. To these regular applications of bor-

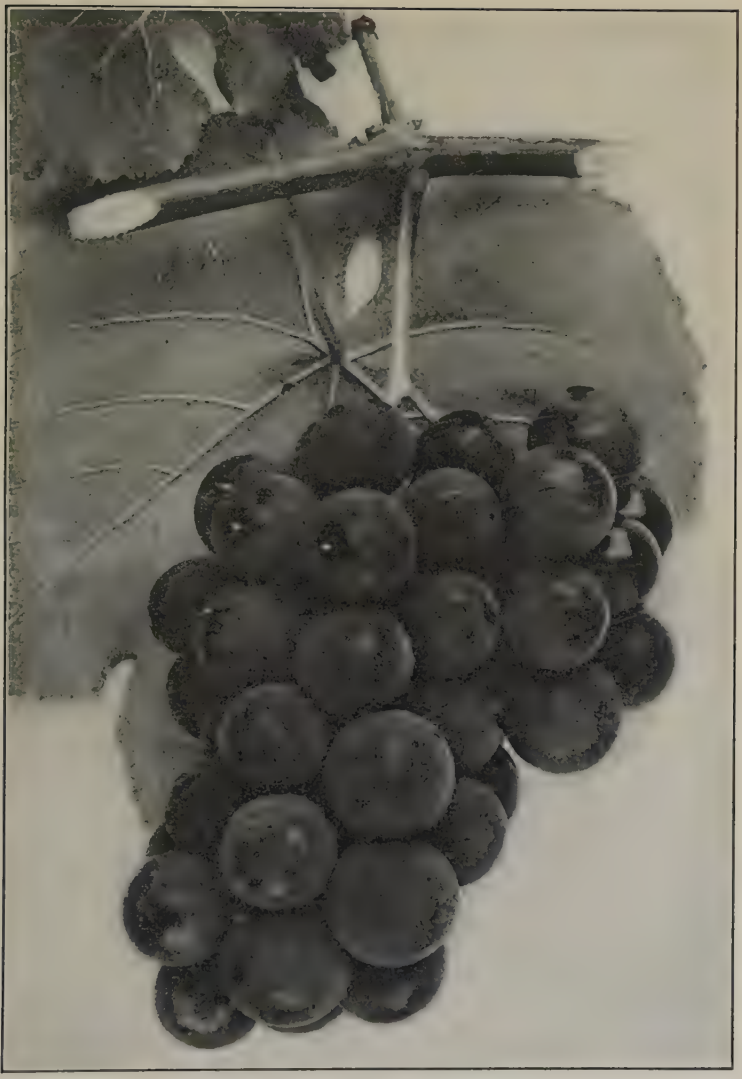

PLATE XVIII. — Herbert ($\times \frac{2}{3}$).

deaux mixture and arsenate of lead, contact insecticides, as some of the nicotine preparations, may have to be added; or, for special purposes as specified in discussing the several pests, cheap molasses is added. It is doubtful, however, whether the grape can be grown with commercial success where insects and fungi prevail and are so pestiferous as to require annually more than two or three applications of spraying mixtures.

CHAPTER XIII

MARKETING THE CROPS AND VINEYARD RETURNS

Viticulture, as all divisions of agriculture, is made up of two quite distinct phases of activity: growing the crop and marketing the crop. The subjects to be treated in this and the next chapter belong rather more to marketing than to cultural activities. Treated in detail, these operations constitute matter sufficient for a separate treatise, and only an outline of present practices is in place in a text such as this devoted to the culture of the fruit. The several operations to be discussed are picking, packing, storing, shipping and marketing.

Harvesting in the East and North

As the consummation of the care of the vine, the in-gathering of the crop is celebrated in all European countries with rejoicings in song, dance and mirth. In America the vintage is less of an event than in Europe, but it is more picturesque and diverting than the harvest of most other crops. It is work in which youth and old age, as well as those in the prime of life in both sexes, can take part and is reputed as a most healthful occupation. For these reasons, the grape harvest in America, as in Europe, has somewhat the air of a holiday, so that workers are usually readily found for the several operations of harvesting. Laborers come as grapes begin to ripen from near-by cities and towns and neighboring country-sides in such numbers that the care of the crop is speedily accomplished.

Pickers.

As a rule, pickers are hired by the piece rather than by the day, experience having demonstrated that so paid they do more and better work. There is usually much diversity in race, age and condition of life of pickers so that harmonious and efficient work is scarcely possible without a competent foreman in charge who must often be assisted by a sub-foreman. Efficient supervision doubles the picking capacity of a gang of workers, and, moreover, is necessary to see that the fruit is picked and packed with proper care. In hiring pickers, it is usually stipulated that a part of the pay is to be reserved until the close of the season; otherwise those disposed to have a holiday leave when the weather becomes unpleasant or seek greener pastures when the grapes become scarce.

Time to pick.

Unlike some fruits, grapes must not be picked until they are fully ripe, as unripe grapes do not mature after picking. Grapes not matured lack the necessary percentage of sugar and solids to keep well and have not developed their full flavor. Many growers make the mistake of sending grapes to the market before fully ripe, a mistake easily made with some varieties because they acquire full color before full maturity. Color, therefore, is not a good guide as to the time to pick. In the northern and eastern states, late varieties of grapes may be allowed to hang on the vines for some little time after maturity, the late autumn suns giving them a higher degree of sweetness and perfection. Some growers run the risks of light frosts to further maturity and to secure the added advantage of the removal of many leaves from the vines. Ripeness is indicated by a combination of signs difficult to describe but easily learned by experience. These signs are: first, a characteristic color; second, full development of flavor and aroma; third, a softer

texture of the pulp and a slight thickening of the juice so that it is more or less sticky; fourth, the ends of the stems turn from green to brown; fifth, the berries pull more readily from their stems; sixth, the seeds are free or more nearly free from the pulp and usually turn from green to brown.

Picking appliances.

But few appliances are needed in picking grapes. Shears are a necessity. These are of special make and can be bought from dealers in horticultural supplies, costing from 75 cents to $1. Some growers, after picking, pack the fruit in the field in the receptacles in which it is to go to market. The greater number, however, pick in trays which are taken to the packing-house and allowed to stand until the fruit is wilted before packing for shipment. Trays may be of several sizes and shapes, but are usually shallow flats holding from twenty-five to thirty-five pounds. The picked fruit is taken from the vineyard to the packing-shed in a wagon with flexible springs to prevent jarring and jolting. Large growers usually have specially built one-horse platform wagons, the front wheels of which pass under the platform.

Picking accounts.

It is no small matter to keep a picking account with pickers. Business-like growers use one of several kinds of tickets or tags in keeping accounts. Probably the most common method is to give a ticket to the picker when the receptacle of grapes is delivered, the grower either keeping half of the original or a duplicate of it. Objections to ticket systems are that the pickers often lose the tickets, are irregular in returning them, or exchange them with other pickers. To obviate the disadvantages of tickets, some growers use tags which bear the picker's name and are attached to his person. These tags have marginal numbers or divisions which are canceled by a

punch as pickers deliver the grapes. Still another method is to keep book accounts with each picker in which case payment is made by the pound, each receptacle being put on the scales as brought in from the field, credit being given for the number of pounds. It is the duty of those in charge to see that each picker finishes the row or the part of the row to which he is assigned, and that he does not wander over the vineyard in search of the best picking.

Packing-houses and their appliances.

The commercial grape-grower must have a house for packing and storing. Houses differ in design and fitting for almost every vineyard. Sometimes the house is a combination one for packing and storing. Often the packing-house is a half-way place between the vineyard and the shipping station, in which case it is an open shed or a lightly constructed building. In these field packing-houses there are usually no provisions for storing. The better types of combined houses are provided with a cellar for the storage of grapes, the first floor is used for packing, and the attic provides a place for the storage of baskets and crates. In all such houses provision must be made for thorough ventilation, especially for the storage cellar if the grapes are to be kept for any length of time. Properly ventilated, the temperature of the grape cellar can be kept as low as 50° F. during September and October. The cellar floor in these houses is usually of dirt better to regulate the moisture-content of the room. Often the first floor is divided into two rooms, one to be used for packing and the other as a shipping room. A good combination packing-and-storage-house of this type can be built for $1000 to $2000. Now that cold storage facilities can be secured in most grape-growing regions, and the rates of storage are becoming more reasonable, there is less need of storage-houses.

Packing-houses are so simple in construction and may be so

different in design that it is neither possible nor necessary to describe them in detail. A building that protects the workers from the elements and affords conveniences in packing serves the purpose. Such a packing-house, which is often located in the vineyard, should be well lighted, should be connected with the storage-room for baskets and should have advantages for delivering the packages from the storage-room to the packing-room and from the packing-room to the shipping-room. Its size will depend on the quantities of grapes to be packed. The house must be built so that it can be kept clean and sweet.

Every packing-house, whatever the design, must be furnished with tables for holding the trays while the fruit is being packed. Usually these tables are so made that the picking trays are set before the packers on an inclined table. The packer transfers the grapes from the trays into the baskets in which the fruit is to be sold. The trays of grapes as they come from the field are set before the packers either in front or a little to the right of the worker, who then packs the fruit into the basket from the left. As the baskets are filled, they are placed on a flat ledge or shelf in front of the packer and are then taken off by an attendant. Empty baskets are usually held in store on a higher shelf convenient to the packer and from time to time are replenished by the attendant. Figure 46 shows a packing-table of the kind just described. Sometimes

FIG. 46. Packing grapes on a packing-table.

the packing-table is circular and revolves, the packers sitting about the table. The baskets are held on the lap and the packer takes the grapes off the table which is turned as fresh fruit is brought in. This circular table is not in general use; its only advantage is that it permits the packer to select from a larger quantity of fruit.

Grading grapes.

Grapes are more easily graded than most other fruits; for usually there are but two grades, firsts and culls. It is difficult to specify exactly what firsts are, since a number of factors must be considered which bring in play the judgment of the grader. At least, firsts must have the following qualities: The bunches must be approximately uniform in size; there must be few or no berries missing from the stems; the grapes must be fully ripe, of a uniform degree of ripeness and uniformly colored; and the fruit must be free from insect and fungous injuries. It is easier to give specifications for culls, since all grapes not firsts are culls.

In large vineyards, only good fruit or the best fruit is worth grading. It is more advisable to sell poor fruit by the ton with little or no grading. It follows, also, that the higher the price, the more special the market, and the more carefully the crop is picked, the more profitable it is to grade. The work of grading is done in the packing-shed when the fruit is transferred from the trays into the selling receptacles. A pair of slender scissors made for the purpose, to be purchased from dealers in horticultural supplies, is used to trim out diseased and crushed berries. The fruit must be permitted to wilt for a few hours, a half day or overnight, before it can be graded to advantage. In this work of grading, the greatest care should be taken to keep the fruit clean and fresh, to sort out broken bunches and to preserve the bloom. The less handling, the more finely finished is the product.

Grape packages in eastern grape regions.

Packages for grapes are less varied than those for any other fruit, selling receptacles in the states east of the Rocky Mountains being much the same for all regions. Dessert grapes are universally packed in gift packages — that is, packages which are given away when the fruit is sold — and this insures a clean dainty package. It seems imperative that a uniform style of package should be used the country over for the general market, but up until this time, although there have been both national and state laws passed, uniformity has not been secured. A national law is needed establishing standard commercial packages so that the grower may safely ship from one state to another without being a law-breaker. Such a package should be based on cubic-measure and not on weight as is often advocated; for grapes cannot be shipped without some loss from sampling in transit; and there are also losses in weight by evaporation so that the grower, although trying to comply with the law, may become technically a law-breaker if the standard is based on weight.

Fig. 47. Climax baskets in two sizes.

The most popular package for the grape in eastern grape regions is the Climax basket made in various styles and sizes. These are cheap, easily packed and handled, nest well in shipment and are durable. Three sizes are commonest in use, the five-pound, the ten-pound and the twenty-pound basket. The five-pound basket usually holds only a little over four pounds; the ten-pound about eight pounds; and the twenty-pound rather less

than twenty pounds. Two sizes of Climax baskets are shown in Fig. 47. It is commonly understood, however, that the packages are short in weight, and as grapes are retailed by the basket and not by the pound, short weight does not really deceive.

These baskets are made of thin wood veneer with a light wood binding at the top and bottom. The cover is of wood and is usually fastened on with staples. The handle is either of wood or of wire. When well made, the baskets are firm and symmetrical, without splinters and are clean and white. Packages carried over from year to year become dingy in color, but the wood may be whitened by fumigating in the storage-room with sulfur. The baskets also become yellow and discolored if left in the sun and must, therefore, be stored in clean, dark, dry rooms.

When grapes are sold by weight to manufacturers of wine or grape-juice, they are usually delivered in the picking trays which, if the market is near at hand, are always returned. If they are to be shipped far, they go to market in twenty-pound baskets or bushel baskets, although the latter are not regarded with favor by consumers.

Packing.

Grapes packed indoors, as has been said, are allowed to stand from a few to twenty-four hours after being picked to permit them to wilt. When thus wilted they are much more easily packed and do not shrink in transportation, so that the basket usually reaches the market well filled with fruit. Each bunch of grapes is placed separately in the basket after all unmarketable berries have been removed. The bunches are arranged in concentric tiers, the top layer being placed with special care. When the basket is filled, the grapes rise a little above the level of the basket, care being taken not to have the fruit project too much so that the grapes will be crushed when

putting on the cover. In all this work, the berries are handled as little as possible, so as not to destroy the bloom. Care is taken, also, that the fruit is free from spraying material and is otherwise clean and fresh. Much less pains need be taken when the grapes are packed in trays to be sold by weight, but even in this there must be method in filling the trays, otherwise there will be many open spaces and corners between bunches.

Practically all commercial grape-growers now use labels on their packages. These not only add to the attractiveness of the packages, but are a guarantee of the contents, both as to name of the variety and the quality of the fruit. These labels are, also, a sign by which a grower's fruit may be distinguished and are, therefore, a valuable advertising medium. Some growers have registered their labels in the United States Patent Office in order to prevent others from using them. Obviously, it is not desirable or worth while to label a poor grade of grapes.

Storing grapes.

The commercial grape-grower now stores his grapes in cold storage warehouses if he keeps them any length of time after harvesting. There is no question but that keeping a part of the crop in artificially cooled houses is a great benefit to the grape-grower, since it prolongs the season for selling by some three or four months. Formerly, native grapes could be secured in general markets only until Thanksgiving time or thereabouts, but now American grapes are very generally offered for sale in January and February, while the European grapes from California are in the market nearly the year around. The grape-grower need make little or no preparation of his product in putting it in cold storage except to make sure that the product is first class in every respect. It would be a waste of money and effort to attempt to store any but clean, sound, well-matured, well-packed grapes. The grape-grower, however,

seldom need concern himself with storing, since the crop is usually stored by the buyers.

Few small growers seem to have learned the art of keeping grapes in common storage. There are but few difficulties in keeping European grapes for several months after picking if they are stored under favorable conditions. Not all, but several of the native grapes may also be kept practically throughout the winter if proper precautions are taken. Among these varieties Catawba is the standard winter sort, but Diana, Iona, Isabella, Rogers' hybrids and Vergennes, all rather commonly grown, may be kept by the small grower.

To insure keeping, these native grapes must be handled most carefully. The fruit is picked a few days before it is dead ripe and the bunches placed in trays holding forty or fifty pounds. It is important that the temperature be reduced gradually so that there are no sudden changes. If the nights are cool, a valuable aid is to leave the grapes out-of-doors in crates the night after they are picked, placing them in a cool building or dry cellar early the next morning. The cellar or store-room should be well ventilated and should be such that the temperature is not variable, care being taken that the air in every part of the storage room is changed. Draughts, however, should be avoided or stems and berries will shrivel. If a temperature from 40° to 50° can be maintained, the varieties named may be kept until March or April. An expensive store-room is not necessary and ice to cool the room is not only unnecessary but undesirable.

If the storage-room is too dry, the grapes wilt and lose flavor; if, on the other hand, the atmosphere is too damp, the grapes mold. It is essential, therefore, to strike a medium between an atmosphere too dry and one too wet. It is possible that a light fumigation with sulfur or formaldehyde might help to keep down molds in these common storage grape-rooms, but as to the value of fumigation there seems to be no experimental evidence.

Grapes grown on clay lands are said to be firmer and to keep better than those grown on gravel or lighter soils. Some years ago there was an association in Ohio known as The Clay-Growers Association which handled only grapes grown on clay lands. The members of this association believed that their grapes were much more desirable for storage than grapes from regions where the soil was lighter.

Harvesting and Handling Muscadine Grapes

The Muscadine grapes of the South Atlantic and Gulf states are unique in vine and fruit, are used for different purposes and go to different markets from the grapes of the North, so that they may be considered almost a distinct fruit. Not only are cultural requirements peculiar to this fruit, as we have seen, but the methods of harvesting and marketing are quite distinct. These are well set forth by Husmann and Dearing[1] as follows:

"Rotundifolia vines have been almost entirely grown on overhead arbors in the past, the fruit being made into wine, and under such conditions the general practice of jarring the grapes from the vines is perhaps the most practical method of harvesting. If the vines are trained to upright trellises or if the fruit is intended for shipping or table use the grapes should be picked by hand in order to be sound and clean. On account of the presence of leaves, twigs, etc., mixed with the grapes jarred from the vines, wine and grape-juice manufacturers will pay 5 to 15 cents a bushel more for hand-picked grapes. The growers who make a practice of hand picking claim that the work can be done at practically no greater expense than is necessary to shake off and clean a crop, and the increased price obtained for the fruit will more than pay the difference.

[1] Husmann, Geo. C., and Dearing, Charles. *The Muscadine Grapes*, U. S. Dept. Agr. Bul. 273: 33–36. 1913.

"A description of the harvesting of the Rotundifolia grapes by the jarring method will be interesting to those not familiar with it. Poles are attached to sheets of canvas measuring 6 by 12 feet and having leather handles. A man is placed at each end of the sheets and four men with two sheets work together. The wide sides of the two sheets are brought close together under each vine, with the trunk of the vine in the middle. The vines are then jarred, the berries falling into the sheets. Those not caught by the sheets or that have fallen to the ground by the shaking of the trellis when the fruit of the adjoining vines was harvested, etc., and which are usually of the best quality, are picked by hand. The writers are informed that it costs approximately 15 cents a bushel to harvest the fruit on the ground and 12 cents to harvest that which falls on the sheets.

"The fruit is put in boxes or barrels, and if the quantity is not large the leaves, sticks, etc., which become mixed with the fruit are removed by hand. If there is a considerable quantity of fruit some mechanical means, such as ordinary grain fan mills, are used to clean it. After cleaning, the fruit is hauled or shipped to the winery. In wineries with modern equipment there are blowers which thoroughly clean the fruit. These are located near the end of the elevators that carry the fruit to the crusher.

"A common and very objectionable practice followed in harvesting Rotundifolia grapes, especially by the jarring method, is that of gathering the fruit all at once, whereas there should be at least three periods of harvesting. When harvested at one time the best quality of fruit ripens, falls to the ground, and is lost before the harvest is commenced and the last part of the crop is thrashed from the vines in a half-ripe condition along with the ripe fruit. In this manner not only is the first and best fruit entirely lost, but the harvested fruit is inferior in quality, which necessarily results in a poor product from the entire yield."

Returns from Muscadine grapes.

"Great variations occur in the yields from Rotundifolia vines. At times there are record-breaking yields and, again, small yields are reported, the small yields resulting from black-rot, coulure, wet weather, self-sterility, lack of cultivation, fertilization, lack of pruning, age of vines, and various other causes. In spite of this, Rotundifolia vines are said to be among the safest and most prolific of fruit-bearing plants. While in one of the largest Rotundifolia vineyards there has been only a partial crop during the last three years, owing to various causes, another grower reports a yield of 177 bushels of grapes from 4-year-old James vines, in addition to a bale of cotton to the acre. A Florida grower estimated his crop of white Rotundifolia and Thomas grapes for the season of 1911 at 280 bushels to the acre. An average yield of 27 bushels an acre from 4-year-old vines, 100 bushels from 5-year-old vines, and 150 bushels to the acre when the vines are in full bearing should be obtained.

"The prices paid for Rotundifolia grapes depend on the season, the quality of fruit, and the market. In years when the crop is short better prices are usually paid than when there is a heavy crop. Aside from the grapes sold and shipped to wineries, grapes as a rule sell for more in the cities and larger towns than in smaller places, the local demand being somewhat in proportion to the population. In such localities fruit of good quality will bring a much better price than inferior fruit. Hand-picked fruit in half-bushel peach baskets or in berry boxes usually brings from $1 to $2 per bushel. Grapes harvested by jarring are usually sent to the wineries and bring an average of 75 cents per bushel of 60 pounds. The highest price paid for this quality of fruit was reached in 1910, when $2.25 per bushel (f.o.b. shipping point) was paid for white Rotundifolia.

"In many localities certain growers have built up quite a reputation for themselves in choice, hand-picked fruit, which they ship to special customers in distant markets. For this purpose the James variety is usually grown because the berries adhere well and are of good size and flavor. Several growers ship as far north as New York and Boston, getting from $2.00 to $2.50 gross per bushel crate. In shipping, three styles of carriers are used — the 24-box strawberry crate, the 6-basket peach crate, and the 8-pound basket. More attention should be given to this phase of the industry. The varieties best suited for shipping are the James, Memory, Flowers, and Mish.

"In the fall of 1910 shipments of the James, Thomas, and Eden varieties were sent from the Rotundifolia experiment vineyard at Willard, N. C., to Washington D. C., part of the consignment being in strawberry boxes and the remainder in bushel baskets. No important difference could be noted in the two lots on their arrival in Washington. The James variety arrived in perfect condition in both packages; of the Eden 30 per cent and of the Thomas 35 per cent had shelled. More extensive experiments along this line are contemplated."

Handling the Grape in California

Grapes are grown in California for three purposes, wine, raisins and the table. The handling of the crop for raisins and wine is best taken up in a discussion of these products in the chapter on by-products of the grape, leaving only table grapes to be discussed at this place.

The table-grape industry of the Pacific slope is dependent on the wide distribution of the product in eastern markets for a profitable sale of the crop, since production is so great that but a small part of the crop is consumed in the markets of the Pacific slope. The growers in this region, therefore, have special problems, chief of which are those of successful shipment over

long distances. California annually ships in the neighborhood of 10,000 carloads of table grapes, all of which must be handled within a period of about two months. As competition increases, it becomes more and more necessary to extend the area over which the fruit is to be sold; to lengthen the marketing season through cold storage; and for both of these purposes to devise new or to improve present methods of handling the fruit. The two requisites for the successful shipment of this great bulk of grapes are: The fruit must reach the markets in sound condition; and it must have sufficient market-holding quality to remain sound for a considerable length of time after it arrives in the markets. Experience has thoroughly demonstrated to grape-growers in California that decay in grapes is largely dependent on the presence of injuries to the grape berries, to the pedicels or to the stems of the bunches. Methods of handling grapes, therefore, and the type of package used, must be such that the product is injured as little as possible.

Careful handling.

In the shipment of European grapes from California, it has been found that it pays to go to much extra trouble in handling the crop. The bunches are picked with care to avoid bruising or crushing berries, and as far as possible they are lifted only by the main stems. They are then laid with care in the picking trays which are filled only one layer deep. In moving the trays to the packing-house, they are handled carefully, the trays being moved only on wagons with springs. In sorting, special care is taken to remove all injured and unsound berries and not to injure others in the bunch, here again handling the clusters by the stems. In packing, the bunches are placed firmly in the baskets with care not to crush or bruise the stems or to injure the pedicels of the berries. A slight injury of either berry or pedicel permits the spores of the fungus causing decay to gain entrance into the fruit.

Shipping packages.

The most common package for table-grapes in California is a square basket holding about five pounds. These baskets are placed for shipment in fours in crates. The bunches of some varieties may be too large for these small baskets, and these extra large-clustered grapes are packed in oblong baskets holding in the neighborhood of eight pounds, two baskets filling a crate. No good filler seems yet to have been devised for packing grapes in California. The cork dust in which grapes from the Mediterranean are received is not available and a good substitute has not yet been found. Sawdust is sometimes used but has not proved satisfactory in holding the decay and the fruit absorbs disagreeable flavors from the wood. Occasionally, however, grapes from California are sent to eastern markets packed in dry redwood sawdust and these seem to come through in good condition and not to have absorbed a disagreeable flavor. Reports seem to indicate that this specially selected redwood sawdust is proving much better than the ordinary sawdust experimented with some years ago.

Shipping.

Considerable work has been done by the United States Department of Agriculture to determine how table-grapes could best be shipped from the far West and reach the eastern markets in good condition. The crop is, of course, shipped in refrigerator cars and much depends on the cooling of these cars and especially on the temperature at which the grapes are kept while in transit. To carry well over the 3000 miles of mountain and desert, heat and cold, the best type of refrigerator car must be used. It does not appear that the pre-cooling so advantageous to citrous and other tree-fruits is worth the trouble and expense with table-grapes, as it does not seem to prevent decay. Cooling cannot be substituted for careful handling,

which seems as yet the most necessary precaution to be taken in the preparation of these grapes for eastern shipment.

Marketing

Table-grapes from both eastern and western grape regions are now almost entirely shipped in carload lots. Since few grape-growers are prepared to load a car quickly with grapes, some kind of coöperation is required, or the crop must be handled by large buyers. Coöperative methods are becoming more and more popular, although a large part of the grape crop, both East and West, is now handled by buyers.

There are several important advantages in selling through a coöperative organization. Thus, in selling coöperatively, the grapes are graded and packed in accordance with one standard; more favorable transportation rates can be secured by a co-operative association; and, most important of all, the output can be distributed to the grape markets of the country without the disastrous competition that attends individual marketing. In some of these organizations, also, supplies needed by the grape-grower in producing a crop are purchased more economically than by individuals; in particular, grape packages can be purchased better by an organization than by an individual.

As the grape industry and competition grow in the different regions of the country, the necessity of forming marketing organizations becomes greater. Such organizations must be founded on the principles which many experiments have shown best govern fruit-marketing associations. It is not possible to discuss these principles at length, but the following fundamentals will suffice:

An ideal coöperative association is one in which there are no profits nor dividends. Every member of the whole organized association is a producer. All of the product grown by a member is sold through the association. The association is

democratic, all members having an equal voice in its management and all sharing alike in its successes and failures. When profits arise of necessity, they are distributed to the members of the association in proportion to the amount of business each has done. The work of the organization is conducted at as near cost as possible and profits are declared only after expenses, depreciation, interest on capital for future operations are deducted. Thus it is seen that the plan of the organization is to give each member as nearly as possible the exact price his fruit has brought in the markets.

Vineyard Returns

Grape-growing as a business is a comparatively new industry in America. It is true that the first attempts at growing this fruit were made to found an industry, but these were complete and dismal failures, and the start in growing grapes in America eventually came as a pleasing hobby. In evolving from a hobby into vineyard culture on a large scale, the business side of the industry long lagged. At present, with increasing competition, manifold uncertainties in vineyard conditions, and much unbusinesslike administration, interest in cultural operations, with which pioneers in the industry were chiefly concerned, is eclipsed by the conception that grape-growing is a highly developed commercial enterprise requiring for success careful business management.

Unfortunately there is nowhere a substantial body of figures from which growers can obtain a fair conception of what the outgo and income of average vineyards in grape regions are. The value of such data to investors or to those making an effort to keep track of the finances of their business is obvious, and an attempt is made here to put the reader in possession of figures that ought to be helpful. The data given, although scant and fragmentary, show fairly accurately the cost of

producing grapes, selling prices and profits in the culture of this fruit in one of the great grape regions.

The New York Agricultural Experiment Station is carrying on experiments to determine the outgo and income from vineyards in the Chautauqua grape-belt. The work is not yet finished, nor could the findings be published in detail before being sent out by the Station, but F. E. Gladwin, in charge of the work, has consented to set down summaries of costs and returns taken from vineyards at Fredonia, which will serve as a guide to planters of grapes in this region at least:

First Year

Interest on value of land @ $200 per acre	$12.00
Preparation of land	8.00
Cost of vines per acre	12.00
Planting	4.00
Cultivating	6.00
Total expenditure for first year	$42.00

Second Year

Interest on value of vineyard @ $225 per acre	$13.50
Cultivating, hand hoeing, etc.	9.25
Pruning	1.00
Total expenditure for second year	$23.75

Third Year

Interest on value of vineyard @ $250 per acre		$15.00
Pruning		2.50
Posts (cost of) @ .10 240		24.00
Setting and driving		6.50
Wire and wiring, staples, etc.		11.65
Tying and twine		1.45
Cultivating, plowing, harrowing		9.25
Spraying		4.00
No. baskets sold @ .16 per basket 500	$80.00	
Cost of baskets @ $20 per thousand		10.00
Picking @ .01 per basket		5.00

PLATE XIX. — Iona ($\times \frac{3}{5}$).

Packing @ .01 per basket		$5.00
Hauling .003		1.50
Outgo for third year		$95.85
Income	$80.00	

Fourth Year

Interest on value of vineyard @ $300 per acre		$18.00
Pruning		2.50
Tying		2.90
Spraying and materials		4.00
Cultivating, plowing, harrowing, hand-hoeing and plowing back one furrow		9.25
Trellis upkeep, driving posts, tightening wires, etc.		2.50
Pulling and poling out brush		1.69
No. baskets sold @ .16 per basket 1000	$160.00	
Cost of baskets @ $20 per thousand		20.00
Picking @ .01 per basket		10.00
Packing @ .01 per basket		10.00
Hauling .003		3.00
Outgo for fourth year		$83.84
Income	$160.00	

Outgo for four years	$245.44
Income for four years	240.00

Estimates for Succeeding Years

Gross income	$125–200
Outgo	75– 85

CHAPTER XIV

GRAPE PRODUCTS

Over-production, with the attendant losses caused by glutted markets, is a factor which, like frosts and freezes, is ever in the mind of the grape-grower. No season passes but that some of the grape regions of the country suffer from over-production. Not uncommonly the grape industry in a region is better off in a season when the crop is small and prices high, than when the crop is large and prices low. In every part of the country where grapes are grown, over-production has been a great deterrent to viticulture; this, in spite of the fact that grape-growers have availed themselves of the opportunity to manufacture products from this fruit. Thus, wine and raisins are made from the grape in California, and a large part of the harvest in the East goes into wine, champagne and grape-juice. But the growth of prohibition now threatens the wine and champagne industries of the country, in fact may be said to have driven them to the wall, making the need of new outlets in manufactured products a greater necessity.

Under these conditions, grape-growers must seek in every way to enlarge the sale of the crop to manufacturers with the hope that thus, together with more perfect distribution of his commodities, the inroads made by prohibition on the industry may be offset and the over-production of table-grapes be better prevented. With this brief emphasis on the importance of manufactured products of the grape, we approach the dis-

cussion of the several possible outlets to over-production in this fruit.

Wine

The manufacture and use of wine in America, as has been intimated, is likely to cease through prohibition. Therefore, whatever may be said of this product of the grape is of less and less interest to grape-growers. However, a few years of grace probably remain for the making of wines in America, and since wine-making yet offers the greatest outlet for the grape crop, next to table-grapes, wine must be considered as a factor in the grape industry.

Since the demand and price for grapes depend very largely on the kind of wine to be made, it is necessary to characterize the wines made in America. Wine, it should be said, is the product of alcoholic fermentation of the grape. Alcoholic fermentations made from other fruits are not, strictly speaking, wines. Natural wines are divided into three broad groups; dry, sweet and sparkling wines. Dry wines are those in which sugar has been eliminated by fermentation; sweet wines those in which sufficient sugar remains to give a sweet taste; and sparkling wines are those which contain sufficient carbonic acid gas to give a pressure of several atmospheres in the bottle. The carbonic acid gas is produced in sparkling wines by fermentation in the bottle of a dry wine.

The color in these three classes of wine may be red or white, depending on whether or not the color is extracted from the skins in the process of fermentation. To make red wine, of course, the grapes to be fermented must have red coloring matter in skin or juice or both. Each of these groups of wine includes a very large number of kinds distinguished by the name of the region, the locality or the name of the vineyard in which a wine is made. Wines are still further distinguished according to the year of the vintage.

Wine-making.

There are four distinct stages in the making of wine after the grapes are grown. The first is the harvesting of the grapes when they have reached the proper stage of maturity, which is known as "wine-making ripeness." This stage of ripeness is determined by means of a must-scale or saccharometer. The wine-maker squeezes the juice from a number of bunches of grapes into a receptacle into which he drops the must-scale, whereupon the sugar-content of the juice is indicated on the scale, determining whether the proper stage of ripeness has been reached. Suitable varieties of grapes having been grown, it is necessary that they be permitted to hang on the vine until the proper degree of ripeness is developed, after which they are delivered at the winery as free as possible from injury or decay.

The second stage is the preparation of the grapes for fermentation. The grapes are weighed on arriving at the winery and are then conveyed either by hand or more often by a mechanical conveyor to the hopper or crusher. The ancient method of crushing, which still prevails in some parts of Europe, was to tramp the grapes with bare feet or wooden shoes. Tramping has been superseded by mechanical crushers which break the skin but do not crush the seeds. The best mechanical crushers consist of two-grooved revolving cylinders. As the grapes pass through the crusher, they fall into the stemmer, a machine which tears off the stems, discharging them at one end, while the seeds, skins, pulp and juice pass through the bottom to the presses usually on the floor below. There are several types of wine-presses, all of which, however, are modifications of screw, hydraulic or knuckle-joint power. In large wineries, the hydraulic press has almost driven out the other two forms of power and when great quantities of grapes must be handled a number of hydraulic presses are usually in operation. The

grape pomace is built up into a "cheese" by the use of cloths and racks variously arranged. The "cheese" is then put under heavy pressure from which the juice or "must" is quickly extracted.

The third stage is fermentation. The "must" is carried from the press into open tanks or vats which hold from 500 to 5000 gallons or even more. The yeast cells which cause fermentation may be introduced naturally on the skins of the grapes; or in many modern wineries the "must" is sterilized to rid it of undesirable micro-organisms and a "starter" of "wine-yeast" is added to start the fermentation. Yeast organisms attack the sugar and must, breaking it up into alcohol and carbonic acid gas, the latter passing off as it is formed. When active fermentation ceases, the new wine is drawn from the pomace and is put into closed casks or tanks where it undergoes a secondary fermentation, much sediment settling at the bottom of the cask. To rid the new wine of this sediment, it must be drawn off into clean casks, an operation called "racking." The first racking usually takes place within a month or six weeks. A second racking is necessary at the end of the winter and a third is desirable in the summer or fall.

The fourth stage is the aging of the wine. Before aging begins, however, the wine usually must be rendered perfectly clear and bright by "fining." The materials used in fining are isinglass, white of egg or gelatine. These, introduced into the wine, cause undissolved matters to precipitate. The wine is now ready for bottling or consumption. Most wines acquire a more desirable flavor through "aging," a slow oxidation in the bottles.

Champagne.

When champagne wines have gone through their first fermentation, they are racked off into casks to age until their quality can be ascertained, after which a blend of several different

wines is made. This blend is called the "cuvée." The cuvée is bottled and a second fermentation starts. The bottles are now put in cool cellars, corded in horizontal layers with thin strips of wood between each layer of bottles. The champagne in this stage is said to be in "tirage." The carbonic acid gas generated at this second fermentation is confined in the bottles and absorbed by the wine. When the bottle is uncorked, the gas, seeking to escape, produces the sparkling effect desirable in sparkling wines. After the wine has been in tirage for one or two years, the bottles are placed in A-shaped racks, the neck of the bottle pointing downward so that the sediment formed during fermentation drops to the cork. To further the settling of the sediment, workmen turn or shake each bottle daily for a period of one to three months. The bottles are then taken to the finishing room, cork down and the wine is "disgorged." Disgorging is accomplished by freezing a small quantity of wine in the neck of the bottle containing the sediment, after which the cork is removed and with it the frozen sediment. The bottle is refilled, recorked, wired, capped, and the champagne is ready for shipment.

The vintage.

The wine-making season the world over is known as the "vintage." The time at which the vintage begins depends, of course, on the region, the variety of grapes, the growing season and the location of the vineyard. Its duration, also, depends on these same factors. The season is usually lengthened by the fact that wine-makers require for their purposes a number of varieties of grapes which ripen at different times. Before or during the vintage, representatives of wine cellars usually make contracts for the number of tons of grapes required at a certain price a ton.

The notion prevails that grapes for wine and grape-juice need not be first-class. This is far from the truth. To make

good wine the grapes must be carefully harvested, transported with as little injury as possible and must be protected from dirt, mold and fermentation before reaching the winery. European vintagers maintain that grapes picked at sunrise produce the lightest and most limped wines and yield more juice. They say, also, that the grapes should not be gathered in the heat of the day because fermentation sets in at once. These niceties are not observed in America.

Prices paid for wine grapes.

Supply and demand regulate the price paid for wine grapes. There is always demand for good wine grapes, although a poor product often goes begging for market. In the East, the highest prices are paid for the grapes used in making champagne. The champagne region of the East is confined to a few localities along Lake Erie and to western New York about Keuka Lake, where the industry is most largely developed. The varieties used in champagne-making in the East are Delaware, Catawba, Elvira, Dutchess, Iona, Diamond and a few other sorts. Prices differ with the many conditions affecting the grape and champagne industries, perhaps the average price for Catawba, the grape chiefly used in making champagne in this region, being from $40 to $50 a ton. Choicer grapes, as Delaware, Iona and Dutchess, often sell from $75 to $100 a ton. Concords are sometimes utilized in making dry wines in the eastern states, $30 or $40 a ton being the average price. Ives and Norton are much used for red wines and sell for top prices.

Wine-makers in the East are at a disadvantage in producing wines other than champagne, since the price paid on the Pacific slope for wine grapes is much lower. Grapes for sweet wine in California often sell as low as $6 or $7 a ton, the average price being $10 or $12. Grapes for dry wines, such as Zinfandel and Burger, bring on the Pacific coast from $10 to $12 a ton. Choice varieties of grapes in this region, such as Cabernet, Sauvignon,

Petite Sirah and Riesling, bring from $22 to $24. The eastern wine-makers, however, have the advantage of being close to the largest and best markets in the country. Wines made in the East are very different from those made in California and supply a different market.

A few years ago most of the Muscadine grapes grown in the South were used for wine-making. From these grapes wine has been made since colonial times, and for a century there have been some large vineyards of Muscadine grapes in the South from which wine was made in a commercial way. Since Muscadine grapes do not sell well in the markets in competition with the grapes of the North or the Pacific slope, the Muscadine grape industry has been dependent on the wine industry of the section in which the fruit is produced. The growth of prohibition in the South, however, has driven the wine industry to the North and West and there is now little wine manufactured from Muscadine grapes in the South, although some grapes are shipped North for wine-making. The wine made from these grapes is very distinct in flavor and on that account a special trade has been developed for it. It is possible that this special trade will keep up the demand for Muscadine wine so that some part of the crop may be shipped to wine-making states to supply this demand.

Grape-juice

When properly made, grape-juice is the undiluted, unsweetened, unfermented juice of the grape and contains no preservatives, fermentation being prevented by sterilization with heat. The product is as ancient as wine, and, therefore, as the cultivation of the vine, for all wine-making peoples have used new wine or grape-juice as a beverage. For centuries physicians in wine-making countries have prescribed grape-juice as it comes from the wine-press for certain maladies, the

treatment constituting an essential part of the grape-cures of European countries. The process of making an unfermented grape-juice that will keep from season to season as an article of commerce is, however, a modern invention, and is the outcome of the discoveries of the last half century regarding the control of the agents of fermentation.

The manufacture of commercial grape-juice in America, to which country the industry is confined, began as a home practice following the fundamental processes of canning fruit. Toward the close of the last century, several inventive minds discovered methods of making a commercial product and began developing markets for their wares. The beginning of the present century found the new industry in full swing, since which time its growth has been truly marvelous. In 1900 the amount of grape-juice made in the United States was so small as to be negligible in the census report of that year. By 1910, the annual output had reached for the whole country over 1,500,000 gallons and at present writing, 1918, it is well above 3,500,000 gallons per annum. The manufacture of grape-juice is no longer a home industry but a great commercial enterprise. It is an industry closely associated with grape-growing, however, and as such needs further consideration here.

Grape-juice regions.

The manufacture of grape-juice is centered in the Chautauqua grape-belt in New York, Pennsylvania and Ohio. So far, the demand seems to be almost wholly for juices made from native grapes, the juice of European grapes grown on the Pacific slope being so sweet as to be insipid. Possibly 80 per cent of the grape-juice now manufactured in America comes from a single variety, the Concord. There can be no question, however, but that sooner or later grape-juices of distinct qualities will be made from many varieties of grapes, thus giving wider sale and greater variation for the product. A very good spark-

ling grape-juice is now on the market and its reception seems to promise a great increase in the production of an article that closely simulates champagne in color and sparkling vivacity, but not, of course, in taste, since it contains no alcohol. The grape-juice industry has been started and is in a flourishing condition in several other grape regions than the Chautauqua belt which is now its center. There are factories at Sandusky, Ohio, using grapes grown in the Kelly Island district; in southwestern Michigan there are several factories; and the industry still survives at Vineland, New Jersey, which probably should be called the original home of the manufacture of grape-juice. In the South, some grape-juice is made from Muscadine grapes, but this product seems not as yet to have been well received in the markets.

Commercial methods of making grape-juice.

There is at present a great diversity of methods and of apparatus employed in the grape-juice manufacturing plants throughout the country. Since the industry is in its infancy, and the attempt has been made to hold some of the methods as trade secrets, the diversity of methods and appliances is not to be wondered at. No doubt there will be greater uniformity of method and machinery and, therefore, greater efficiency, as the industry develops.

Husmann[1] gives the following account of the manufacture of grape-juice in the eastern states and in California:

"Sound, ripe, but not overripe, grapes are used. These are first crushed or, in case the stems are to be removed, are run through a combined stemmer and crusher. If the machinery is stationed high enough, the crushed fruit can be run through chutes directly into the presses or kettles; otherwise, it must be pumped into them by means of a pomace or must pump or carried in pomace carts or tubs.

[1] Husmann, George C. U. S. Dept. Agr. Farmers' Bul. No. 644.

"If a white or light colored juice is desired, the crushed grapes are first pressed, the juice which comes from the press being heated to about 165° F., skimmed, run through a pasteurizer at a temperature of between 175° and 200° F. into well-sterilized containers, and then placed in storage.

"If a colored juice is desired, the crushed grapes are heated immediately, usually in aluminum kettles having double bottoms, which prevent the steam from coming in contact with the contents. These kettles usually contain revolving cylinders, the arms of which keep the crushed grapes thoroughly stirred while they are being heated to about 140° F. The simultaneous heating and stirring help to extract the coloring matter from the skins, tear the cells of the berries, increase the quantity of juice obtained per ton of fruit, and give to the must many ingredients of red wine, with the substitution of grape sugar for alcohol of the wine.

"The aluminum kettles are filled and emptied in rotation, thereby making continuous manipulation possible. The presses should be situated below the kettles, so that the hot juice can be drained directly into them. The expressed juice is then reheated to about 165° F., skimmed, and run through the pasteurizer in the same manner in which the white juice is handled. The juice passes from the pasteurizer while still hot (about 160° F.) into the container, which should be sealed immediately. The lower the temperature (above the freezing point) at which these containers are then stored, the less is the danger of fermentation and the more rapidly the juice will clear and deposit its sediment.

"The ordinary receptacles in which the juice is stored are 5-gallon demijohns, 20-gallon carboys, or clean, new barrels or puncheons, well washed and drained. All containers should be thoroughly sterilized before they are filled, and the covers, corks, bungs, cloths, etc., used in sealing them should be scrupulously clean and carefully sterilized. If barrels or puncheons are used

as containers, they are placed on skids and firmly wedged to prevent movement. As the juice cools, air laden with fermentation germs is apt to be drawn into the barrels by the decrease in the volume of the liquid. In order to prevent this, tight air-filtering plugs of sterilized cotton are sometimes used instead of the ordinary bungs of solid wood.

"The type of pasteurizer differs in almost every establishment. As the industry is of comparatively recent development commercially, there are few models on the market and each manufacturer has constructed the model best suited to his particular ideas or requirements. There are two general types, however, (1) open, double-bottomed kettles in which the juice is heated to the required temperature and then drawn off, and (2) continuous pasteurizers in which the juice is heated to the required temperature as it passes through the water bath.

"The presses also show great variation in different establishments, either hydraulic, screw or lever power being used, and there is a marked difference between the types of pomace containers. Sometimes the crushed grapes are heaped on burlap cloths the sides of which are folded in, and these burlaps are placed one on top of the other in the press; sometimes press baskets take the place of these burlaps.

"The manufacturers in California and those in the grape-growing regions of the Rocky Mountains seem to have adopted entirely different methods of handling the juice after it is first pasteurized and stored. Most of the eastern juices are red and are obtained from the Labrusca varieties, generally the Concord. When the juice comes from the presses, some manufacturers strain it to remove the coarse particles and then pour it directly into well-sterilized bottles; others siphon it off the sediment in the containers in which it is stored after the first pasteurization and pour it into pasteurized bottles. In either case, the bottles are securely corked and then repasteurized. The California juices, however, both red and white, are made

exclusively from Vinifera varieties. They are allowed to settle in the original containers and are siphoned out of these and carefully filtered to make them clear and bright.

"The clearing of the juice is sometimes facilitated by fining or adding a small quantity of a substance which coagulates and when settling carries down with it the solid matters causing cloudiness in the liquid. Such finings may be applied at the time of the first pasteurization or just before the final filtration and bottling. In the latter case the juice is drawn off the settlings in containers, the finings are added, and the juice again pasteurized into other receptacles. When it clears, it is either bottled directly or first passed through a filter, drawn into carefully sterilized bottles, securely corked, and then re-pasteurized. Care must be taken that the final sterilization is not at a higher temperature than the previous one; otherwise, solid matter may be precipitated and the must clouded again.

"A simple and efficient form of sterilizer consists of a wooden trough provided with a wooden grating which is raised 2 inches from the bottom and on which rest the filled bottles in wire baskets. The trough contains enough water to submerge the bottles and is kept at a temperature of 185° F. by means of a steam coil beneath the grating. It requires about 15 minutes for the must at the bottom of the bottles to reach that temperature; for packages of other sizes it is necessary to make a test with a thermometer in order to determine how long it takes for the entire contents to reach 185°.

"To prevent the corks from being expelled during sterilization, they are either tied down with a strong twine or with some contrivance such as the cork holder. In order that mold germs may not enter the must through the corks, especially if a poor quality of cork is used, the necks of the corked bottles are dipped in heated paraffin before putting on the caps, or the corks are sealed down with sealing wax. It is also well to keep the bottles on their rider to prevent the corks drying out."

Home methods of making grape-juice.

The principles involved in making grape-juice in the home are the same as those used in canning. The grapes may be crushed by hand or in mills similar or identical with the small cider-mills owned by many farmers. In making a light-colored juice, the crushed grapes are put in a cloth sack and hung up to drain, or the filled sack may be twisted by two persons until the greater part of the juice is expressed. The juice is then sterilized in a double-boiler by heating it at a temperature of 180° to 200° F., care being taken that the thermometer never goes above 200°. The sterilized juice is now poured into a glass or enameled vessel to stand for twenty-four hours, after which it is drained from the sediment and strained through several thicknesses of clean flannel. The juice is now put in clean bottles preparatory to a second sterilization, care being taken that at least an inch of space is left at the top for the liquid to expand when heated. The second sterilization may be conducted in a wash-boiler or similar receptacle. The filled bottles must not rest on the bottom of the boiler but should be separated from it with a thin board. The boiler is filled with water up to within an inch of the tops of the bottles and heated until the water begins to boil. The bottles should then be taken out and corked immediately, using only new corks. After corking, the bottles are further sealed by dipping the corks in melted paraffin. A cheap corking machine is a great convenience in this work, and in any case the corks should be soaked for at least a half hour in warm but not boiling water.

The process varies somewhat in the making of red grape-juice. The crushed grapes are heated to a temperature of 200° F., and are then strained through a drip bag without pressure, after which the liquid is set away in glass or enamel vessels to settle for twenty-four hours. Except for this difference in the pre-

liminary treatment of the juice, the methods are the same in making the red or the light-colored product. For proper keeping it is not necessary to let the juice settle after it is strained, but a clearer and brighter product is obtained if the juice is permitted to settle. In either case the grape-juice should keep indefinitely if the work has been well done. As soon as bottles are opened, fermentation begins with the formation of alcohol.

Raisins

The grape is best conserved as a raisin. Canning is seldom practiced with this fruit. A raisin is a dried grape. Tree-fruits are evaporated as by-products, but the raisin is a primary product. This is a difference worth noting; for with tree-fruits the cream of the crop goes to the fresh fruit market, while with the grape the entire crop of raisin varieties may go into the cured product. The raisin industry is dependent on a sunny and rainless climate and hence in America is confined to the grape regions of certain parts of California. In this state, raisin-making is a rich resource of the grape-grower, the annual output now averaging well above 200,000 pounds, grown on 120,000 acres of land, and having a market value of $10,000-000. Fresno County, California, produces nearly 60 per cent of the output of the state and the city of Fresno is the center of the industry. The raisin industry does not stand alone in California, as some raisin grapes, notably Muscat of Alexandria, are good dessert sorts and are also much used for wine and brandy. Only the first crop of the variety named is used for raisins, while practically all of the second crop each season is made into wine and brandy.

Raisins proper are mostly made from the Muscat of Alexandria, although other large, white, sweet grapes are sometimes used. Sultana raisins, naturally seedless, are made from Sultanina and the Sultana. The dried currants of commerce

are made from grapes, and of these California produces small quantities from White Corinth.

The following account of raisin-making is given by Husmann :[1]

"In the raisin districts grapes are ripe by the middle of August, the season often lasting into November. The average time necessary for drying and curing a tray of raisins is about three weeks, depending on the weather, the earliest picked grapes drying in ten days and the later ones often taking four weeks or more.

"The method of drying is very simple. The bunches are cut from the vines and placed in shallow trays 2 feet wide, 3 feet long, and 1 inch high on which the grapes are allowed to sun-dry, being turned from time to time by simply placing an empty tray upside down on the full one and then turning both over and taking off the top tray. After the raisins are dried they are stored away until they are packed and prepared for shipment. Some of the larger growers, in order not to run so much risk in drying on account of rain, and also to enable them to handle the crop fast enough, have curing houses, where the curing is finished after having been partially done outside."

Dipping and scalding raisins.

"The operation of dipping and scalding is designed to accomplish several purposes, namely, to cleanse the fruit, to hasten its drying, and to give the dried fruit a lighter color. In dipping and drying, the fruit, immediately after being cut from the vines, is either dipped in clear water to first rinse it of particles of dust and other foreign matter, or it is taken direct to the scalder and immersed in a boiling alkaline mixture called 'legia' (lye) until the grapes show an almost imperceptible cracking of the skin, the operation consuming perhaps from one-fourth to one-half of a minute. This dipping calls for skill on the part of the

[1] Husmann, George C. U. S. Dept. Agr. Bul. No. 349. 1916.

operator, the duration of the emersion depending on the strength and temperature of the mixture and the condition of the fruit. Desiccation follows the scalding process, which is accomplished on trays in the sun, the same as undipped raisins cured entirely by solar heat. On account of the scald they cure rapidly, and the fruit is also often of lighter color when cured.

"The following formula has been used for Sultana and Sultanina grapes at Fresno:

"Fifteen pounds of 'Greenbank's 98-per cent lye' are boiled in 100 gallons of water. This mixture is for grapes containing 25 per cent of sugar. Should their sugar content be less, enough lye is added to remove the bloom and open the pores of the skin of the grapes. After dipping, the grapes are spread on trays and sulphured for 1 to 1½ hours. Observation will show whether it may be necessary to vary this formula a trifle to suit conditions of ripeness and influence of temperature. The length of time required for dipping is ascertained by experience, and differs with the strength of the lye, the heat of the solution, and the thickness of the skins of the grapes."

Packing raisins.

"The raisins as received at the packing house are weighed and the loose raisins and those that are to be shipped as dried grapes are immediately run through a stemmer and grader which stems, cleans, and assorts the raisins into three or four different grades, after which they are packed and shipped to various parts of the country, some also being exported. Those producing cluster or layer raisins (if they have not already been equalized) are first stored in the equalizing rooms. In these rooms the sweat boxes, filled with layers of new raisins, are stacked and left usually from 10 to 30 days, or long enough for the overdried berries to absorb moisture from the underdried ones. This sweating also properly softens and toughens the stems, which prevents their breaking and enables them to hold the berries better. In California, where the climate is so dry, no first class pack could be made without thus first equalizing the raisins. After having been equalized the raisins are

taken out, assorted into the different grades, and placed in trays holding 5 pounds each. The trays of the same grades are then pressed and stacked away in piles ready for packing.

"Pressing the raisins so that they look well and so none are burst open is work requiring experience and good judgment. It takes four pressed trays to fill a 20-pound box. The loose raisins that have dropped from the cluster through handling before they were equalized are also graded, the largest, of course, making the choicest pack."

Classes of raisins.

"Previous to the consolidated organization of the packers the three best grades of raisins on the stems were known as 'Imperial,' 'Dehesia,' and 'Fancy Clusters,' respectively. The California Raisin Growers Association established classification and grades similar to those of the Spanish raisin packers, on which the French trade names are also based. The original Spanish, as well as English terms with which they correspond, and the different grades in descending order of quality are shown in the following table:

Spanish Terms	French Terms	English Terms	California Terms
Imperial	Imperiaux Extra	Extra Imperial	Six-Crown Cluster
Imperial Bajo	Imperiaux	Cluster	Five-Crown Cluster
Royan Bajo	Royaux	Imperial Cluster	Four-Crown Cluster
Cuarta (4a)	Surchoix Extra	Royal Cluster	Three-Crown Cluster
Quinta (5a)	Choix Extra	Choicest	Two-Crown Cluster
		Choice Cluster	

"The grading is optical, as a result of experience, there being no linear or cubic measurement standard. Thus, a nice cluster

with all berries of large size, would be a 'Six-Crown Cluster,' such being the very finest raisins on the stem. 'Five-Crown Clusters' were formerly the 'Dehesia' cluster, and 'Four-Crown Clusters' were formerly 'Fancy Clusters.' Gra 'es less than 'Four-Crown' on the stems (the 'Three-Crown' and 'Two-Crown') are known as 'Layers,' or 'London Layers.' These are placed in boxes containing 20 pounds net; in half boxes of 10 pounds; and quarter boxes of 5 pounds; and in fancy boxes containing 2½ pounds. Loose raisins, or raisins off the stem, are graded into Two-Crown, Three-Crown, and Four-Crown raisins by being run through screens the meshes of which are thirteen thirty-seconds, seventeen thirty-seconds, and twenty-two thirty-seconds of an inch in size, respectively. The Sultanina (erroneously called Thompson Seedless), and the Sultana are packed in 12-ounce cartons, 45 to the case."

Seeded raisins.

"The invention of a raisin-seeding machine by George E. Pettit in the early seventies, and its use, has had a wonderful effect on the industry.

"Seeded raisins were first put on the market by the late Col. William Forsythe, of Fresno, Cal., who at first found it very difficult to dispose of 20 tons. The output in the last 15 years has increased from 700 tons to 50,000 tons per annum, and their popularity is constantly increasing. In 1900 about 14,000 tons were placed on the market, in 1905 about 21,000 tons, in 1910 about 31,000 tons, and in 1913 about 49,000 tons. The seeding machines in present use can turn out 300 tons per day. Seeded raisins are now the most important branch of the raisin industry.

"A brief outline of how seeded raisins are prepared will prove interesting. The raisins are first exposed to a dry temperature of 140° F. for three to five hours, after which they are put through a chilling process so that the pedicels can be

easily removed, and are then thoroughly cleansed by being passed through cleaning machines. They are then taken by automatic carriers to another room, spread out on trays, and exposed to a moist temperature of 130° F. to bring them back to their normal condition. The raisins pass to the seeding machine, where they are carried between rubber-faced rollers and the impaling device of the seeding machine which catches the seeds and removes them from the fruits as they are flattened between the surfaces of the rollers. The impaled seeds are removed from the roller by a whisking device in such a way as to be caught in a separate receptacle. The seeded raisins pass through chutes to the packing tables on the floor below.

"The seeded or loose raisins are packed in 50-pound boxes; in 1-pound cartons, 36 to the case; in 12-ounce cartons, 45 to the case; and some in bulk in 25-pound boxes.

"Information has recently been sent out to the effect that the California Associated Raisin Co. is arranging to do away with the grades in seeded raisins, so there will only be one grade. This contemplates using all of the Three-Crown, the smallest of the Four-Crown, and the best of the Two-Crown in one blended grade.

"From the seeds, formerly used as a fuel, a number of by-products are now made.

"The seeds and pedicels removed from the raisins in seeding vary from 10 to 12 per cent of the original weight of the raisins according to their conditions and quality.

"The grading, seeding, facing, and packing have become separate branches of the industry, and the work is nearly all done by especially trained women, who have become experts at it. The establishments in which this work is done furnish employment for over 5000 persons. The aggregate pay roll each month during the season is between $200,000 and $350,000."

Grape-vinegar

A very good vinegar can be made from grapes, although as yet this outlet for over-production is not largely utilized in America. Grapes which are unsuitable for raisins, dessert, wine-making or grape-juice can be used for vinegar-making. Under the most favorable conditions, grape-vinegar cannot compete in cheapness with vinegar made from numerous other products and must, therefore, always sell at a high price. Indeed, it is doubtful whether a high-grade grape-vinegar can be manufactured at a less price than good wine. The production of grape-vinegar requires as much care, but possibly not as much expert knowledge, as the making of wine. Unlike the latter, however, the vinegar can be produced on a small scale for domestic purposes by any one possessing a knowledge of wine-making or vinegar-making.

Grape-vinegar may be manufactured from either white or red grapes, although that from white grapes is generally preferred. It may be made either directly from grapes or from wine, the acetifying process being the same for both. There are, therefore, two distinct stages in the manufacture of this product. First, there must be alcoholic fermentation by which the sugar in the grape is changed into alcohol with the escape of carbonic acid gas. Second, acetic fermentation must follow the alcoholic fermentation by which the alcohol is changed into acetic acid.

By-products of Grape Industries

There are several valuable by-products in the wine-making and grape-juice industries, and even raisin-making yields a by-product in the seeds taken from the raisins. The utilization of these wastes has been rendered profitable in Europe, and there is no reason why by-products should not yield considerable profit in America, as a few already do. Good authorities

state that if all the wastes of the grape crop could be utilized the value of the crop would be increased over 10 per cent.

Pomace.

The pomace or marc, the residue left after grape pressing, is the most valuable of the by-products of the wine and grape-juice manufacturers. If the pomace is permitted to ferment, and afterwards is distilled, a product called pomace-brandy is made. Unscrupulous wine-makers often add water and sugar to pomace, after which it is refermented and the resulting product is sold as wine. Notwithstanding the fact that the word "wine" as applied to this product is a misnomer, the total amount of such wine made and consumed in America is large. Piquette is another product in which the pomace is put into fermenting vats, sprinkled with water and the liquid after a time is drawn off, carrying with it the wine contained in the pomace. This liquid is re-used in other pomace, until it is high enough in alcoholic strength, when it is distilled into "piquette" or "wash."

In Europe, the pomace from stemmed grapes is said to make a sheep and cattle food of more or less value when salted slightly and stored in silos. The pomace is also oftentimes used as a manure, for which it has considerable to recommend it, being rich in potash and nitrogen. Acetic acid is made from pomace by drying it in vapor-tight rooms, during which process 50 to 60 per cent of the weight of the pomace becomes vapor, and this, condensed, yields considerable quantities of acetic acid.

Cream-of-tartar.

The lees of wine, the sediment which settles in the casks in which new wine or grape-juice is stored, form a grayish or reddish crust on the inside of the receptacle. This is the argol or wine-stone of the wine-maker, and from it is made cream-of-tartar, an article considerably used in medicine, the arts and

for culinary purposes. From 20 to 70 per cent of the lees consist of either cream-of-tartar, or of calcium tartrate, the latter also having commercial value. Red wines are much richer in argol than white wines. A ton of grapes yields from one to two pounds of argol. This product becomes a source of considerable profit in large wineries and in grape-juice manufacturing plants.

Seeds.

In Europe, the seeds are separated from the pomace and used in various ways. They are also utilized to a smaller extent in America, especially when separated from raisins. The seeds are used as food for horses, cattle and poultry, for which they are said to have considerable value. If crushed and ground, the seeds yield a clear yellow oil which burns without smoke or smell and which may also be employed as a substitute for olive oil. A ton of grapes yields from forty to one hundred pounds of seeds from which may be made from three to sixteen pounds of oil. This oil is also used as a substitute for linseed oil and in soap-making. Besides oil, the seeds yield tannin. After the oil and tannin have been taken from the seeds, there remains a meal which may still be utilized as a stock food or as a fertilizer.

Domestic Uses for Grapes

At present, when food conservation is being emphasized everywhere, mention of the domestic use for grapes is particularly appropriate. The country over, no fruit is more generally grown than the grape; yet grape products are not as common for home use as those of several other fruits, although many attractive and appetizing preserves can be made from grapes without the use of large quantities of sugar, spices or other ingredients. Few housekeepers realize the high quality and the cheapness of the products that can be made from the grape. Thus, grape-juice, jelly, jam, marmalade, grape-butter,

catsup, spiced grapes, canned grapes, conserves in which grapes are used, preserves and mince-meat are among the desirable culinary products easily and cheaply prepared from home-grown grapes or those bought in the market. Only simple domestic utensils are needed in the preparation of any of these products.

Grape-sirup is less easily produced, yet can be made in any home without the addition of sugar. It is not only a good table sirup, but is a most useful sugar substitute for the preparation of other culinary products. The Muscadine grapes in the South, to be purchased by almost every householder in southeastern United States, in particular, are useful for these domestic products. Recipes for all of these products can be found in cook books, and one or two bulletins and circulars from the United States Department of Agriculture give recipes for preparing grapes for domestic purposes. Farmers' Bulletin 859 entitled *Home Uses for Muscadine Grapes* is a particularly valuable publication on this subject.

It is interesting to note that several large manufacturers of grape-juice are putting on the market grape jams, jellies and marmalades. It would seem that these delicious and wholesome products would find a ready sale in the markets of the country, and that their manufacture would prove profitable to the maker and to the grape-grower. The greater the use of grapes for their products, the better the grower can breast the blows of unfavorable markets and over-production.

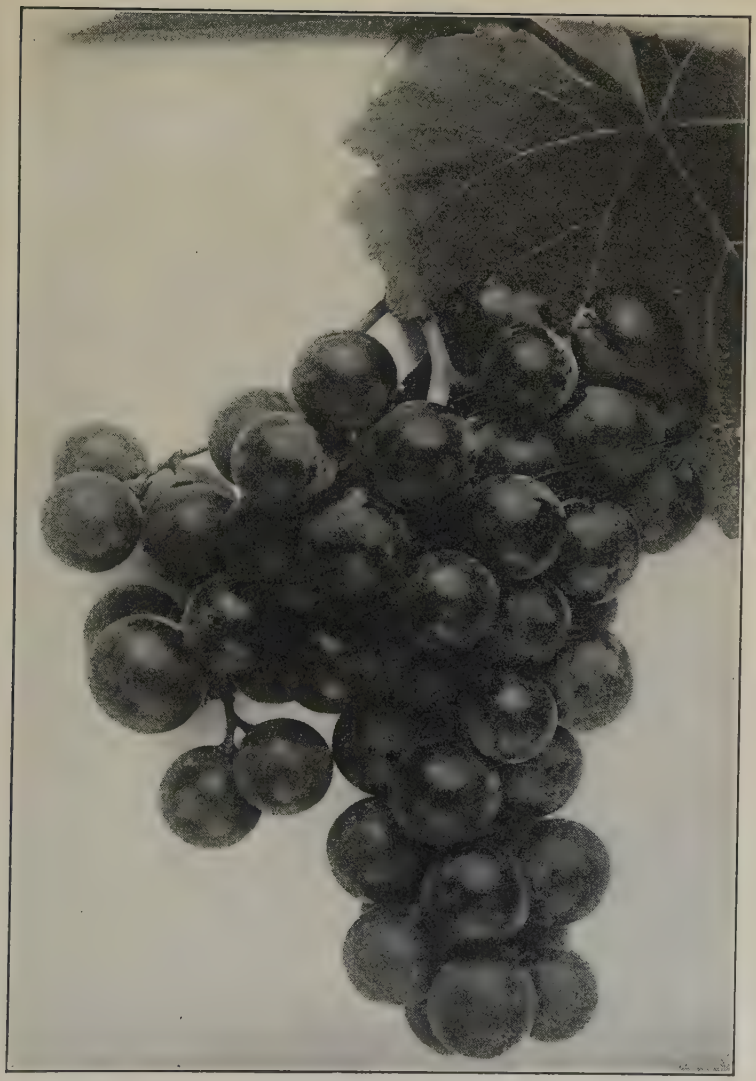

PLATE XX. — Isabella ($\times \frac{2}{3}$).

CHAPTER XV

GRAPE-BREEDING

CHANCE, pure and simple, has been the greatest factor in the production of varieties of American grapes. From the millions of wild plants, an occasional grape of pre-eminent merit has caught the eye of the cultivator and has been brought into the vineyard to be the progenitor of a new variety. Or in the vineyards, more often in near-by waste lands, from the prodigious number of seedlings that spring up, pure or cross-bred, a plant of merit becomes the foundation of a new variety. An interesting fact in the domestication of the four chief species of American grapes is that none came under cultivation until forms of them, striking in value, had been found. Catawba, representing the Labrusca grapes; the Scuppernong, the Rotundifolias; Norton, from *Vitis æstivalis;* Delaware and Herbemont from the Bourquiniana grapes; and Clinton from *Vitis vulpina*, are, after a century, scarcely excelled, although in each species there are now many new varieties.

That our best grapes have come from chance is not because of a lack of human effort to produce superior varieties. Of all fruits, the grape has received most attention in America from the generation of plant-breeders just passing. Grape-breeders have produced 2000 or more varieties, a medley of the heterogeneous characters of a dozen species. That so many of this vast number are worthless is due more to a lack of knowledge of plant-breeding than to a lack of effort, for the order and system in plant-breeding that now prevail, disclosed by recent brilliant discoveries, were unknown to grape-breeders of the last century.

Grape Hybrids

As early as 1822, Nuttall, a noted botanist, then at Harvard, recommended "hybrids betwixt the European vine and those of the United States which would better answer the variable climates of North America." In 1830, William Robert Prince, Fig. 48, fourth proprietor of the then famous Linnean Botanic Nursery at Flushing, Long Island, grew 10,000 seedling grapes "from admixture under every variety of circumstance." This was probably the first attempt on a large scale to improve the native grapes by hybridizing, although little seems to have come of it. Later, a Dr. Valk, also of Flushing, grew hybrids from which he obtained Ada, the first named hybrid, the introduction of which started hybridizers to work in all parts of the country where grapes were grown.

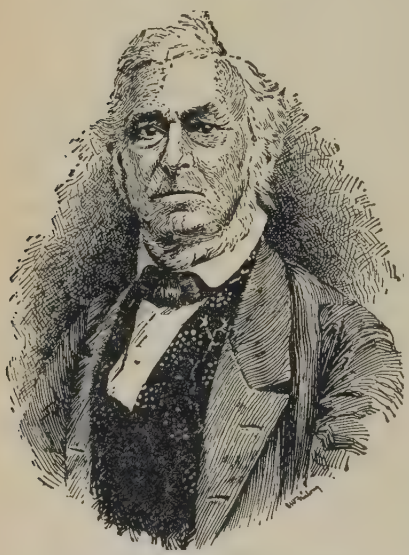

Fig. 48. William Robert Prince.

Soon after Valk's hybrid was sent out, E. S. Rogers, Fig. 49, Salem, Massachusetts, and J. H. Ricketts, Newburgh, New York, began to give viticulturists hybrids of the European Vinifera and the American species which were so promising that enthusiasm and speculation in grape-growing ran riot. Never before nor since has grape-growing received the attention in America as given during the introduction of Rogers' hybrids. It was the expectation of all that we were to grow in America,

in these hybrids, grapes but little inferior, if at all, to those of Europe.

A statement of the difference between European and American grapes shows why American viticulturists have been so eager to grow either pure-breds from the foreign grape or hybrids with it.

Fig. 49. E. S. Rogers.

European grapes have a higher sugar-and-solid content than the American species; they, therefore, make better wines and keep much longer after harvesting and can be made into raisins. Also, they have a greater variety of flavors, which are more delicate, yet richer, with a pleasanter aroma, seldom so acid, and are always lacking the disagreeable, rancid odor and taste, the "foxiness," of many American varieties. There is, however, an unpleasant astringency in some of the foreign grapes, and many varieties are without character of flavor. American table-grapes, on the other hand, are more refreshing, the unfermented juice makes a pleasanter drink, and lacking sweetness and richness, they do not cloy the appetite so quickly. The bunches and berries of the European grapes are larger, more attractive and are borne in greater quantities. The pulp, seeds and skins are somewhat objectionable in all of the native species and scarcely so at all in the Old World sorts. The berries of the native grapes shell from the stem so quickly that the bunches do not ship well. The vines of the Old World grapes are more compact in habit and require less pruning and training than do those of the native grapes; and, as a species,

probably through long cultivation, they are adapted to more kinds of soil, to greater differences in environment and are more easily propagated than the American species.

Because of these points of superiority in the Old World grape, since Valk, Allen and Rogers showed the way, American grape-breeders have sought to unite by hybridization the good characters of the Old World grape with those of the American. Nearly half of the 2000 grapes cultivated in eastern America have more or less European blood in them. Yet, despite the efforts of the breeders, few of these hybrids have commercial value. Whether because they are naturally better fixed, or long cultivation has more firmly established them, the vine characters of *Vitis vinifera* more often appear in varieties arising as primary hybrids between that and the native species, and the weaknesses of the foreign grape, which prevent their cultivation in America, crop out. Hybrids in which the vinifera blood is more attenuated, as secondary or tertiary crosses, give better results.

Several secondary hybrids now rank among the best of the cultivated grapes. Examples are Brighton and Diamond. The first is a cross between Diana-Hamburg, a hybrid of a Vinifera and a Labrusca, crossed in its turn with Concord, a Labrusca; the second is a cross between Iona, also a hybrid between a Vinifera and a Labrusca, crossed with Concord. Both were grown from seed planted by Jacob Moore, Brighton. New York, in 1870. Brighton was the first secondary hybrid to attract the attention of grape-breeders, and its advent marked an important step in breeding grapes.

The signal success achieved by hybridizers of the European grape with native species quickly led to similar amalgamations among American species. Jacob Rommel, of Morrison, Missouri, beginning work about 1860, hybridized Labrusca and Vulpina grapes so successfully that a dozen or more of his varieties are still cultivated. All are characterized by great vigor

and productiveness; and, although they lack the qualities which make good table-grapes, they are among the best for wine-making. Rommel has had many followers in hybridizing native species, chief of whom was the late T. V. Munson, Fig. 50, Denison, Texas, who literally made every combination of grapes possible, grew thousands of seedlings and produced many valuable varieties.

Fig. 50. T. V. Munson.

Improvement by selection.

Selection, continued through successive generations, so important in the improvement of field and garden plants, has played but small part in the domestication of the grape. The period between planting and fruiting is so long that progress would be slow indeed were this method relied on. Moreover, selection, as a method in breeding, is possible only when plants are bred pure, and it is the experience of grape-breeders that in pure breeding this fruit loses in vigor and productiveness and that the variations are exceedingly slight and unstable. Many pure-bred grapes have been raised on the grounds of the New York Agricultural Experiment Station under the eyes of the writer, of which very few have surpassed the parent or have shown promise for the practice of selection.

New varieties from sports.

Bud-sports or mutations now and then arise in grapes. But not more than two or three of the 2000 varieties now under cultivation are suspected of having arisen in this way. It is

true that mutations seem to occur rather often in grapes, but they are easily confused with variations due to environment and are usually too vague to lay hands on. Until the causes of these mutations are known and until they can be produced and controlled, but little can be hoped for in the amelioration of grapes through mutations.

Hybridizing the Grape

Hybridization has been the chief means of improving the grape. At present, from what is being accomplished by many workers, it looks as if it will long continue to be the best means of improving this fruit. Since the grape-grower must depend on new varieties for progress, as old varieties cannot be changed, it should be the ambition of growers to produce varieties better than those we now have. Many amateur and professional grape-growers in the past have found breeding grapes a pleasing and profitable hobby, so that much knowledge has accumulated in regard to manipulating the plants in hybridization, and the results that follow in the offspring of hybridization.

How to hybridize.

It is assumed that the reader is familiar with the botany of flowers and the essential principles in crossing plants. If he is not, he must carefully study the structure of flowers, especially those of the grape, so as to be able to distinguish the different organs and to discover when the pollen and stigma are ready for the work of pollination. He should, also, read any one of several current books on plant-breeding.

The first task in crossing grapes is to remove the anthers before the flower opens, a process known as emasculation. This is necessary to prevent self-pollination. This first operation having been performed, the cluster of grape-flowers must be tied securely in a bag to protect it from foreign pollen which otherwise would surely be carried to the stigma by insects.

As soon as the stigma is ready to receive the pollen, the bag is removed and pollen from the male parent is applied, after which the bag is again put on the flower to remain until the grapes are well set. By examining the stigmas in the flowers of uncovered grapes, the operator can tell approximately whether the covered stigma is ready to receive pollen. The time required after covering depends, of course, on the age of the bud when emasculation takes place. It is, by the way, best to delay emasculation until just before the flowers open, but one must be certain that the anthers have not discharged their pollen before the flower has been emasculated.

Emasculation is a simple operation. The essential organs of the grape-flower are covered by a small cap; this in some grapes must be removed before the anthers can be reached. In many native grapes, however, the cap and the anthers may be removed at one stroke by the operator. The best tool for this is a small pair of forceps. Each of the blades of the forceps in working with native grapes should have a sharp cutting surface, but with Vinifera sorts, where the cap must be removed before the anthers can be reached, forcep blades with a flat surface are best. There is, of course, some danger when the buds are well developed that the pollen may be squeezed out and so reach the stigma or adhere to the instrument and thus contaminate future crosses. The first danger must be avoided carefully by the skill of the operator, while the second is easily overcome by sterilizing the forceps in alcohol. An effort should be made to fertilize as many of the flowers in the cluster as possible, but success is not always certain; when there is doubt, the uncertain flower should be removed from the cluster.

The flower from which the pollen is to be taken must be protected from wind and insects; otherwise pollen from another flower may be left on it. Protection should be given by tying the flowers in a bag while still in bud. There are various ways of obtaining pollen from ripe anthers and applying it to

the stigma of the flowers to be crossed. The simpest is to crush the anthers, thus squeezing out the pollen, after which, with a brush, scalpel or other instrument, it may be placed upon the stigma. A brush is very wasteful of pollen and often becomes a source of contamination to future crosses, so that the scalpel is the better implement of the two. When pollen is plentiful, as will usually be the case when a man is working with vines in his own vineyard, by far the best method is to take the cluster from the male vine and apply the pollen directly to the stigma of the flower to be crossed, thereby making certain of fresh pollen and an abundance of it. The stigma, if pollen suffice, should be covered with pollen.

Grape pollen does not keep well and an effort should be made to have it as fresh as possible. The work of pollination is best performed in bright, sunny weather when the pollen is very dry. As may be seen from the foregoing statements, tools and methods are of less importance than care in doing the work. The only tool absolutely necessary is a pair of forceps, although a hand-lens is often helpful. Bags for covering the flowers should be just large enough and no larger. A bag to cover the pollen-producing flower may well be an ordinary manilla bag sufficiently large to amply cover the flower-cluster. It is helpful, however, to have a light transparent oiled bag through which one can see the condition of the anthers. It is desirable that the bag for the female flower be permitted to remain until the fruits ripen as a protection against birds and fungi. It must, therefore, be of larger size. While the bags are still flat, a hole is made near the opening through which a string is passed which can be tied when the upper end of the bag is squeezed about the cluster.

Choosing the parents.

Very much depends on the immediate parentage in hybridizing grapes. Some varieties when crossed produce much

higher averages of worthy offspring than others. There is so much difference in varieties in this respect that to discover parents so endowed should be the first task of the grape-breeder. Fortunately, considerable work has been done by several experiment stations in breeding grapes, and their accumulated knowledge, together with that from such workers as Rogers, Ricketts, Campbell and Munson, furnishes beginners with good starting points. There is no way possible of discovering what the best progenitors are except by records of performance. Very often varieties of high cultural value are worthless in breeding because their characters seem not to be transmitted to their progeny and, to the contrary, a good-for-nothing variety in the vineyard is often valuable in breeding.

From present knowledge it does not appear that new characters are introduced in plants by hybridizing. A new variety originating from hybridization is but a recombination of the characters of the parents; the combination is new but the characters are not. Thus, one parent of a hybridized grape may contribute color, size, flavor and practically all the characters of the fruit, while the other parent may contribute vigor, hardiness, resistance to disease and the characters of the vine. Or these and other characters in the make-up of a new grape may be intermingled in any mathematical way possible. The grape-breeder must make certain that one or the other of the parents possesses the particular characters he desires in his new grape.

It is now known that the characters of the grape, in common with those of other plants, are inherited in accordance with certain laws discovered by Mendel. The early workers in grape-breeding did not know of these laws and could not take aim in the work they were doing. Consequently, hybridization was a maze in which these breeders often lost themselves. Mendel's discoveries, however, assure a regularity of averages and give a definiteness and constancy

of action which enable the grape-breeder to attain with fair certainty what he wants if he keeps patiently at his task. The grape-breeder should inform himself as to what Mendel's laws are, and on the work that has been done on the inheritance of characters of the grape. A technical bulletin published by the State Experiment Station at Geneva, New York, and another from the North Carolina Station at Raleigh give much information on the inheritance of characters in certain grapes, and further information can be secured by applying to the United States Department of Agriculture at Washington for literature on the subject.

The grape-breeder can hope to progress only by making many combinations between different varieties and growing large numbers of seedlings. He should extend his work to all varieties which show promise in the breeding of grapes for the particular purpose he has in mind. The seed may be saved and planted as directed in the chapter on propagation. Unless he desires to make scientific interpretations of his results, weak seedlings should be discarded the first year, and a second discard may be made before the young plants go in the vineyard. The breeder will soon discover that he can tell fairly well from the character of the seedlings whether they are of sufficient promise to keep. Thus, if the number of leaves is small or if the leaves themselves are small, the vine is of doubtful value; if the internodes are exceedingly long, the prospect is poor; slenderness of cane, if accentuated, does not promise well; on the other hand, great stoutness and very short internodes are not desirable indications. Through these and other signs, the breeder will come quickly to know which vines should eventually go to the vineyard.

Results of Grape-breeding

There are now 2000 or more varieties of grapes of American origin, all produced within approximately a century. It is

PLATE XXI. — Jefferson ($\times \frac{3}{5}$).

doubtful whether any other cultivated plant at any time in the history of the world has attained such importance in so short a time from the wild state as American grapes. It would seem that almost every possible combination between species worth considering has been made. Through hybridization, species and varieties have become so mixed that the grape-breeder cannot now work intelligently with these gross forms and must work with characters rather than with species and varieties which are but combinations of characters. Great progress, it is true, has been made in the past in breeding grapes in America, but the work has been wholly empirical and extremely wasteful. Many varieties have been called, but few have been chosen. With the new knowledge of breeding and with the experience of past workers, progress should be made with greater certainty. From what has been done and from work now under way, it is not too much to say that we shall soon be growing grapes everywhere in America, and kinds so diverse that they will meet not only all purposes to which grapes are now put, but also the demand for better grapes made by more critical consumers.

CHAPTER XVI

MISCELLANIES

THERE yet remain several phases of grape-culture essential to success, none of which quite deserves a chapter and none of which properly falls into any of the foregoing chapters. The subjects are not closely related, are by no means of equal importance, yet all are too important to be relegated to the limbo of an appendix and are, therefore, thrown into a chapter of miscellanies.

CROSS-POLLINATION

The blooming of the vine had little significance to the grape-grower, the blooming period being so late that grapes are seldom caught by frost, until the discovery was made that many varieties of grapes are unable to fertilize themselves, and that failure of crops of these varieties was often due to the self-sterility of the variety. Until this discovery, the uncertainty attending the setting of the grape in these varieties was one of the discouragements of grape-growing. Following investigations of the self-sterility of the tree-fruits, an investigation of the grape showed that the vines of this fruit are often self-sterile. This knowledge has in some degree modified the planting of all home collections and has more or less affected the plantings of commercial sorts.

Varieties of American grapes show most remarkable differences in the degree of self-fertility. Many sorts fruit perfectly without cross-pollination. Others set no fruit whatsoever if cross-pollination is not provided for. Most varieties, however, are found in groups between the two extremes, neither

self-fertile nor self-sterile. Figure 51 shows staminate and perfect clusters on one vine. Some varieties show no variation in the degree of self-sterility or self-fertility; others behave differently in regard to these characters under different environment. Now and then the widest variations are to be found in a variety in respect to self-fertility.

Following the lead of Beach at the New York Agricultural Experiment Station, several workers have made careful studies

FIG. 51. Staminate and perfect clusters on one vine; *right*, staminate; *left*, perfect.

of the self-fertility of the grape, and now the cultivated varieties of native grapes are divided into four groups in accordance with the degree of self-fertility. Class I includes self-fertile varieties having perfect or nearly perfect clusters; Class II includes self-fertile varieties having clusters loose but marketable; Class III includes varieties which are so imperfectly self-fertile that the clusters are generally too loose to be marketable; Class IV includes self-sterile varieties. The following is a list of commonly cultivated grapes classified according to the divisions just given:

CLASSIFICATION OF GRAPES ACCORDING TO SELF-FERTILITY

CLASS I. Clusters perfect or varying from perfect to somewhat loose.

Berckmans	Etta	Pocklington
Bertha	Janesville	Prentiss
Cottage	Lady Washington	Rochester
Croton	Lutie	Senasqua
Delaware	Moore Early	Winchell
Diamond	Niagara	Worden
Diana	Poughkeepsie	

CLASS II. Clusters marketable; moderately compact or loose.

Agawam	Dutchess	Jefferson
Brilliant	Early Victor	Jessica
Brown	Elvira	Lady
Catawba	Empire State	Mills
Champion	Fern Munson	Missouri Riesling
Chautauqua	Hartford	Perkins
Clinton	Iona	Rommel
Colerain	Isabella	Triumph
Concord	Isabella Seedling	Ulster

CLASS III. Clusters unmarketable.

Brighton	Hayes
Canada	Lindley
Dracut Amber	Noah
Eumelan	Northern Muscadine
Geneva	Vergennes

CLASS IV. Self-sterile. No fruit develops on covered clusters.

America	Faith (?)	Maxatawney (?)
Aminia	Gærtner	Merrimac
Barry	Grein Golden	Montefiore
Black Eagle	Hercules	Requa
Clevener	Jewel	Salem
Creveling	Massasoit	Wyoming
Eldorado		

In the main, the cause of infertility, as with other fruits, is the impotency of pollen on the pistils of the same variety.

There are a few cases in which pollen does not seem to be formed abundantly, but these are very few. There are a few cases, also, in which the pistil does not become receptive until after the pollen has lost its vitality; these, however, are very few. In a greater number of cases the pollen is found defective. However, dismissing all of these as the exception, the rule is that self-sterility is due, as has been said, to the lack of affinity between pollen and pistils produced on the vines of some varieties.

Nature is helpful to the grape-grower in giving a guide to self-fertility. The length of stamens is a fairly safe indication of self-fertility. All grapes which are self-fertile bear flowers with long stamens, although the latter are not a sure sign of self-fertility, as a few varieties with long stamens are self-sterile. On the other hand, short or recurved stamens are always associated with complete or nearly complete self-sterility.

The remedy for self-sterility is inter-planting. Only the varieties named in Classes I and II in the foregoing classification should be planted alone. The sorts named in Classes III and IV must be planted near other sorts which bloom at the same time in order that their flowers may be cross-pollinated.

It is evident that the grape-grower must have some knowledge of the relative time that grapes bloom, if he is to plant intelligently to secure cross-pollination. The following table, taken from Bulletin 407 of the New York Agricultural Experiment Station, shows the blooming time of grapes at that Station. Variations due to location and season must be expected, but within the bounds of the regions in which these grapes are grown variations will be slight. When this table is used for other regions than New York, it must be borne in mind that the farther south, the longer the blooming season; the farther north, the shorter the season.

Blooming dates of grapes.

From three years' records, the average length of blooming season for grapes was twenty days, nineteen days in 1912 and 1914 and twenty-two days in 1913. The first date in the average year of 1912 was June 14, while for 1914, it was June 7:

TABLE IV.—SHOWING BLOOMING TIME OF GRAPES

	VERY EARLY	EARLY	MIDSEASON	LATE	VERY LATE		VERY EARLY	EARLY	MIDSEASON	LATE	VERY LATE
Agawam			*			Diana			*		
America				*		Downing			*		
August Giant			*			Dracut Amber		*			
Bacchus	*					Dutchess				*	
Barry			*			Early Victor		*			
Beacon				*		Eaton			*		
Bell		*				Eclipse			*		
Berckmans		*				Eldorado			*		
Black Eagle			*			Elvira		*			
Brighton			*			Empire State			*		
Brilliant			*			Etta			*		
Brown			*			Eumedel			*		
Campbell Early			*			Eumelan				*	
Canada		*				Faith		*			
Canandaigua			*			Fern Munson				*	
Carman					*	Gaertner			*		
Catawba			*			Geneva			*		
Champion		*				Goethe			*		
Chautauqua			*			Gold Coin			*		
Clevener	*					Grein Golden		*			
Clinton	*					Hartford			*		
Colerain			*			Headlight			*		
Columbian						Helen Keller			*		
Imperial			*			Herbert			*		
Concord			*			Hercules			*		
Cottage		*				Hicks			*		
Creveling			*			Hidalgo			*		
Croton				*		Hosford			*		
Delago			*			Iona				*	
Delaware			*			Isabella		*			
Diamond			*			Janesville	*				

TABLE IV. — SHOWING BLOOMING TIME OF GRAPES — *Continued*

	VERY EARLY	EARLY	MIDSEASON	LATE	VERY LATE		VERY EARLY	EARLY	MIDSEASON	LATE	VERY LATE
Jefferson					*	Norton					*
Jessica		*				Oporto	*				
Jewel			*			Ozark				*	
Kensington		*				Peabody			*		
King			*			Perfection			*		
Lady Washington				*		Perkins			*		
Lindley			*			Pierce			*		
Lucile			*			Pocklington			*		
Lutie			*			Poughkeepsie				*	
McPike			*			Prentiss			*		
Manito				*		Rebecca and			*		
Martha			*		*	Regal			*		
Massasoit			*			Requa			*		
Maxatawney			*			Rochester			*		
Merrimac			*			Rommel			*		
Mills			*			Salem			*		
Missouri Riesling		*				Secretary			*		
Montefiore			*			Senasqua					*
Moore Early			*			Stark-Star					*
Moyer			*			Triumph					*
Nectar			*			Ulster		*			
Niagara			*			Vergennes			*		
Noah		*				Winchell			*		
Northern Muscadine		*				Worden			*		
						Wyoming			*		

RINGING GRAPE VINES

The ringing of woody plants is a well-known horticultural practice. Three objects may be attained by ringing: unproductive plants may be brought into bearing by ringing; the size of the fruits may be increased and thereby the plants be made more productive; and the maturity of the fruit may be hastened. In European countries, ringing has long been practiced with all tree-fruits and the grape, but in America the operation is recommended only for the apple and the grape

and with neither fruit is ringing widely practiced. Experiments carried on at the New York Agricultural Experiment Station by Paddock, as reported in Bulletin 151 from this Station, show that ringing may well be practiced by grape-growers under some conditions. Since Paddock's experiments, and possibly to some extent before, the grape has been ringed to produce exhibition fruits or a fancy product for the market.

Ringing consists in taking from the vine a layer of bark around the vine through the cortex and bast of the plant. The width of the wound varies from that of a simple cut made with a knife to a band of bark an inch in diameter. The operation is performed during that period of growth in which the bark peels most readily from the vine, the period of greatest cambial activity. The term "ringing" is preferred to "girdling," a word sometimes used, since the latter properly designates a wound which extends into and usually kills the plant.

The theory of ringing is simple. Unassimilated sap passes from the roots of the plant to the leaves through the outer layer of the woody cylinder. In the leaves this raw material is acted on by various agents, after which it is distributed to the several organs of the plant through vessels in the inner bark. When plants are ringed, the upward flow of sap is continued as before the operation, but the newly made food compounds cannot pass beyond the injury, and therefore the top of the plant is supplied with an extra amount of food at the expense of the parts below the ring. The extra food produces the results noted.

It turns out in practice that ringing is usually harmful to the plant, as one might expect from so unnatural an operation. Injury to the plant arises from the fact that parts of the vine are starved at the expense of other parts; and because, when the bark is removed, the outer layers of the woody cylinder dry out very quickly and thus check to some extent the upward flow of sap through evaporation from the exposed wood.

Thus, not infrequently, the plant's vitality is seriously drained. Nevertheless, vineyards may be found in which ringing has been extensively practiced many seasons in succession and which continue to yield profitable crops, the growers having learned to perform the work of ringing so as to injure the vines but little.

Ringing without harm to the plant depends much on the way in which the vines have been pruned. For instance, if the vines are pruned to the two-arm Kniffin method, the ringing of bark should be done from both arms just beyond the fifth bud. Thus, the ten buds left on the vine produce enough leaf surface to supply the food necessary to keep the vine in vigorous condition. When the four-arm Kniffin method is used, the two top arms only are ringed, and even so three or four buds must be left on each for renewals. Whatever the method of training, it will be seen from these examples that some unringed wood must be left to the vine with which to supply leafy shoots to support the vine. Some growers ring their vines only every other year, thus giving them an opportunity to recover from whatever loss of vigor they may have sustained in the season of ringing.

Several other considerations are important in ringing: First, the vines must not be permitted to carry too large a crop. Again, the amount of fruit on the ringed portion of the vine must depend on the amount of leaf surface not only of the plant but of the ringed arms, each ringed arm acting somewhat independently so far as its crop is concerned. If too many clusters are left on the ringed arms, it always follows that the fruit is inferior and often worthless. Lastly, all fruit between the rings and the trunk must be removed, for it does not mature properly and so adds only to the drain on the plant's vitality.

As to the results, it is certain from the experiments that have been conducted and from the experience of grape-growers, that

the maturity of the fruit is hastened, and berries and bunches are larger when the ringing has been done intelligently. Many growers hold that fruit produced on ringed vines is never quite up to the mark in quality and in firmness of fruit. There seems to be a difference in opinion about this falling off in quality, however, although unquestionably, choice sorts, as Delaware, Iona and Dutchess, suffer more or less in quality. It is commonly agreed, also, that varieties, the fruits of which crack badly, as the Worden, suffer more from cracking on ringed than on unringed vines.

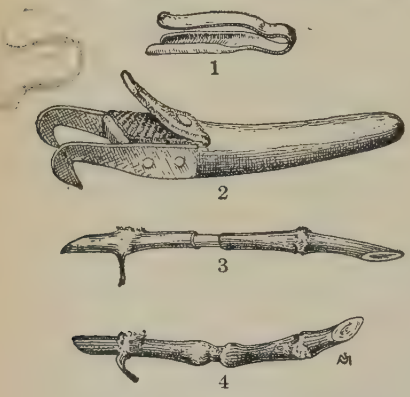

Fig. 52. Tools used in ringing grape-vines are shown in 1 and 2; while 3 and 4 show ringed vines at the beginning and the close of the season.

Experiment and experience prove that the best results of ringing are obtained if the work is done when the grapes are about one-third grown. Of course the exact time depends on the season and on the variety. The operation is variously performed and is easily done with a sharp knife, but when large vineyards are to be ringed the grower ought to provide himself with some simple tool. Paddock, in the bulletin previously mentioned, pictures two of these tools and these are reproduced in Fig. 52.

In conclusion it must be said that it is doubtful whether the gains attained by ringing offset the losses. The practice is chiefly of value only when exhibition clusters of grapes are wanted or when it is necessary to hasten the maturity of the crop. Always, however, the work must be performed with intelligence and judgment or the losses will offset the gains.

Bagging Grapes

In some localities bagging is considered an essential to profitable grape-growing. The bags serve to protect the grapes against birds. In some grape regions vineyards suffer more from the depredations of robins and other birds than from all other troubles. Grapes bearing small berries and having tender pulp and those which shell most readily from the stem suffer most. Of standard sorts, Delaware is probably more enticing to robins than any other variety. There is only one way of preventing damage to grapes from birds and that is by bagging the clusters.

Bagging is also an effective means of protecting the grape from several fungi and insects. In home plantations or small commercial vineyards, bagging the bunches often eliminates the necessity of spraying for fungi and for most of the insects that trouble the grape. Because of the warmth afforded by the bags, bagged grapes ripen a little earlier and are of somewhat higher quality than those not bagged. Grapes bagged are protected from early frost, thus prolonging the season. Grapes that have been protected from the elements during the summer are more attractive than those exposed to the weather, since the fruits are free from weather marks and present a fresh, bright appearance, which puts them in a grade above unbagged grapes. Bagging often enables the grower to sell his crop as a fancy product.

Grapes are bagged as soon as the fruits are well set, the sooner the better if protection against fungi is one of the purposes. Under no circumstances, however, should the clusters be bagged while in blossom. A patent bag made for the purpose may be purchased or, serving equally well, the common one and one-half and two-pound manila bags used by grocers prove satisfactory. One of the patent bags which is known as the Ideal Clasp Bag has a metal clasp attached to the top for

securing the bag in place over the cluster. In using the grocer's bag, before it is put in place the corners of both the top and bottom are cut off by placing several bags on a firm level surface and using a broad-shaped chisel. Cutting off the corners of the top enables the operator to close the bag neatly over the cluster, while cutting off the corners of the bottom furnishes a means of escape for any water that gets in the bag. In putting the bag in place, the top is pinned above the lateral from which the bunch hangs, and must not be fastened about the small stem of the cluster, as the wind blowing the bag almost invariably breaks the cluster from the vine. The largest pins to be purchased in dry-goods stores are used in pinning the bags. The bags remain until the grapes are picked. Wet weather does not injure bags and seemingly they grow stronger with exposure to sun and wind.

The cost of the bags and the work of putting them on is no small item. To secure the best results, the work must be done at the period between the dropping of the blossoms and the formation of the seeds, when the grapes are about the size of a small pea. This is a busy time for the grape-grower, which adds to the cost. When the work is conducted on a large scale, the cost is about two dollars a thousand bags, this figure covering both the cost of bags and labor. Women do the work more expeditiously than men and soon become very skillful in putting on the bags. Despite the trouble and cost of bagging, growers seeking to produce a fancy product find that the expenditure proves profitable.

Winter-protection of Grapes

With a little care as to winter-protection, grapes may be grown profitably in northern regions where, without protection, the vines are killed or injured by low temperatures. Indeed, it is little short of amazing how well grapes can be grown in north-

ern regions where nature wears a most austere countenance in winter, if hardy early sorts are planted in warm soils and situations, and the vines are covered in the winter. Occasionally one finds grapes grown profitably in commercial vineyards in the northern states in regions where protection must be given to prevent winter-killing, the extra work of giving protection being more than offset by the high price received in local markets for the fruit.

In all locations in which winter-protection must be given, several other precautions are helpful or even necessary. Thus, cultivation must cease early in the season, and a cover-crop be sown to help harden and mature the vines. The grapes, also, must not be planted in soils rich in nitrogen, and nitrogenous fertilizers must be applied with care. The pruning should be such as does not induce great growth. These simple precautions to hasten maturity often suffice in climates where the danger of winter-killing is but slight, but where danger is imminent the vines must be covered either by wrapping or by laying down. Wrapping with straw may suffice for a few vines, but when many vines are to be protected, laying them down is cheaper and much more effectual.

By laying down is meant that the vines must be placed on the ground and there be protected by earth and snow or other covering. It is obvious that to protect thus, the vines must receive special training; otherwise the trunks may be too stiff for bending. Some method of training must be chosen in which renewals may be made rather frequently from the ground so that if the trunks become large, clumsy and unpliable, a more manageable trunk can be trained. If the provisions for renewal are kept in mind, any one of the several methods of training grapes explained in Chapter VIII on training may be used.

Laying down must be preceded by pruning, after which the arms and trunk are loosened from the wires and bent to the

ground. Bending is facilitated by removing a spade full of earth from the side of the vine in the direction in which the vine is to be bent. The trunk is then laid on the earth and sufficient soil placed on it to keep it in place on the ground. If the danger of winter-killing is great because of the tenderness of the variety or the austerity of the climate, it often becomes necessary to cover the whole plant lightly with earth. Small growers often make use of coarse manure, straw, corn-stalks or similar covering, in which case the vines are held on the ground by fence-rails or other timbers; but protecting with material that must be brought into the vineyard is expensive and not more satisfactory than earth.

The vines can be put down at any time after the leaves drop and before the earth begins to freeze. It is more important that the vines be taken up at the proper time in the spring. If uncovered too early and cold weather follows, injury may result and more harm be done than if the vines had not been covered. On the other hand, if the earth is permitted to remain too long, foliage and vine are tender both to sunshine and frost. A grape-grower in New York who has had much experience in laying down vines in a vineyard of some thirty or forty acres says that the work may be done at a cost of $6 an acre at the average wage paid for farm-labor. It must be expected in a large plantation, no matter how well the work of covering is done, that occasionally a trunk will be broken, making it necessary to graft the vine if a shoot does not spring up from below the break.

Ripening Dates and Length of Season for Grapes

Every grape-grower should know when his varieties may be expected to ripen and the length of season that they will keep. The commercial fruit-grower by all means should have this information. It is not sufficient that he know only roughly

at what season his varieties ripen; for, to take the turn of the market, he must know exactly when a variety will ripen and how long it will keep. He needs this information, also, that he may distribute his labor better throughout the picking season.

Unfortunately, the data as to ripening time given by originators and introducers of varieties are not always reliable. This untrustworthiness of data is readily accounted for in several ways: First, growers do not generally agree as to when grapes are ripe nor as to how long they are fit to eat. Again, much confusion as to when varieties ripen and how long they will keep arises from the fact that grapes ripen at different times in different places, and it is difficult for the grape-grower in Maine to make allowance in season for varieties, the time of ripening of which is given for Maryland. There are also other causes than the seasonal differences in grape regions for variability in ripening time; thus, some soils are warmer and quicker than others, and on these grapes ripen earlier. Application of nitrogenous fertilizers may delay the period of ripening somewhat. Grapes ripen perceptibly earlier on old plants than on young ones. Lastly, every vineyard in a particular region has its own particular climate caused by the lay of land, nearness to water, air currents and altitude which cause small differences in ripening.

The following table taken from Bulletin No. 408 of the New York Agricultural Experiment Station gives the ripening dates of grapes at Geneva, New York. It is necessary that the reader know something about the conditions affecting the ripening time at Geneva. The latitude is 42° 50′ 46″. The altitude is 525 feet above sea level. The vineyard lies a mile west of a relatively large body of water. The soil is a cold heavy clay which must delay ripening time somewhat. The land is level. The data are given as an average for three seasons, 1913–1915.

The figures given for "weeks in common storage" cover a variable number of years, but for all varieties three or more

years. The grapes, after being picked, were at once placed in common storage in a room on the second floor of a building. There conditions were not ideal, and no doubt the season of storage would have been prolonged somewhat had the fruit been kept in a better storage-room.

TABLE V. — SHOWING THE RIPENING TIME OF GRAPES

	Weeks in Common Storage	Very Early	Early	Midseason	Late	Very Late		Weeks in Common Storage	Very Early	Early	Midseason	Late	Very Late
Agawam					*		Diana	17					*
America			*				Downing					*	
Barry	28			*			Dracut Amber	9		*			
Beacon	7			*			Bell	8		*			
Berckmans	21			*			Dutchess	23			*		
Black Eagle	18			*			Early Ohio		*				
Brighton	20			*			Early Victor	11	*				
Brilliant	11			*			Eaton	6				*	
Brown	6			*			Eclipse	7	*				
Campbell Early	12		*				Eldorado	17	*				
Canada	17				*		Elvira	18			*		
Canandaigua	20				*		Empire State	24				*	
Carman	17			*			Etta	15					*
Catawba	21					*	Eumelan	17		*			
Champion	6		*				Faith	11			*		
Chautauqua	10				*		Fern Munson	11					*
Clevener	13				*		Gaertner	17			*		
Clinton	21					*	Geneva	22		*			
Colerain	8			*			Goethe	18					*
Columbian							Gold Coin	10				*	
Imperial	7				*		Grein Golden	12				*	
Concord	8			*			Hartford	8			*		
Cottage	5		*				Headlight	8	*				
Creveling	16		*				Helen Keller	26				*	
Croton	23	*					Herbert	27			*		
Delago	25					*	Hercules	13				*	
Delaware	15		*				Hicks	10			*		
Diamond	10		*										

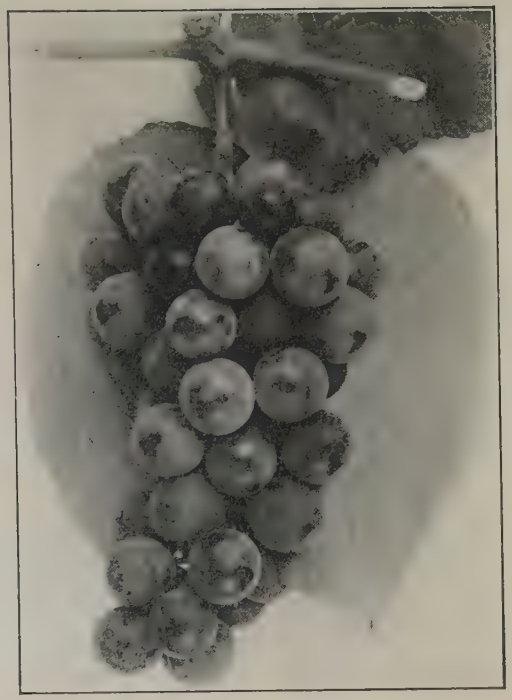

PLATE XXII. — Lindley ($\times \frac{1}{2}$).

Lucile ($\times \frac{1}{2}$).

TABLE V. — SHOWING THE RIPENING TIME OF GRAPES — *Continued*

	Weeks in Common Storage	Very Early	Early	Midseason	Late	Very Late		Weeks in Common Storage	Very Early	Early	Midseason	Late	Very Late
Hidalgo	12			*			Noah	10			*		
Hosford	6				*		Northern Muscadine	9			*		
Iona	13				*		Norton	7					*
Isabella	11			*			Oporto	12			*		
Janesville	13			*			Ozark	11				*	
Jefferson	18					*	Peabody					*	
Jessica	12		*				Perfection	8			*		
Jewel	12		*				Perkins					*	
Kensington	19				*		Pierce	12				*	
King			*				Pocklington			*			
Lady Washington	16				*		Poughkeepsie	15		*			
Lindley	27			*			Prentiss	16				*	
Lucile	9			*			Rebecca	18			*		
Lutie	4	*					Regal	16				*	
McPike	7			*			Requa	30			*		
Manito	7				*		Rochester	7			*		
Martha	10			*			Rommel	10			*		
Massasoit	16			*			Salem	27				*	
Maxatawney	12			*			Secretary	25				*	
Merrimac	31			*			Senasqua	13				*	
Mills	29				*		Stark-Star	10					*
Missouri Riesling	6				*		Triumph	15					*
Montefiore	9			*			Ulster	21				*	
Moore Early	6	*					Vergennes	28				*	
Moyer	9		*				Wilder	11				*	
Nectar	10		*				Winchell	6	*				
Niagara	10		*				Worden	6		*			
							Wyoming	9		*			

CHAPTER XVII

GRAPE BOTANY

The grape-grower must know the gross structure and the habits of growth of the plants properly to propagate, transplant, prune and otherwise care for the grape. Certainly he must have knowledge of the several species from which varieties come if he is to know the kinds of grapes, understand their adaptations to soils and climates, their relation to insects and fungi, and their value for table, wine, grape-juice and other purposes. Fortunately, the botany of the grape is comparatively simple. The organs of vine and fruit are distinctive and easily discerned and there are no nearly related plants cultivated for fruit with which the grape can possibly be confused. Botanists, it is true, have dug pitfalls for those who seek exact knowledge as to the names and characters of the many species, but, fortunately, each of the cultivated species constitutes a natural group so distinct that the grape-grower can hardly mistake one for another in either fruit or vine.

Plant Characters and Growth Habits of the Grape

A grape plant is a complex organism with its many separate parts especially developed to do one or a few kinds of work. The part of a plant devoted to one or a group of functions is called an organ. The chief organs of the plant are the root, stem, bud, flower, leaf, fruit and seed. Flowers and leaves, it is true, develop from buds and the seeds are parts of the fruits,

but for descriptive purposes the vine may well be divided into the parts named. These chief organs are further divided as follows:

The root.

Root-crown: The region of the plant in which root and stem unite.
Tap-root: The prolongation of the stem plunging vertically downward.
Rootlets: The ultimate divisions of the root; usually of one season's growth.
Root-tips: The extreme ends of the rootlets.

The roots of some species of the grape are soft and succulent as those of *V. vinifera*, while the same organs in other species, as in most American grapes, are hard and fibrous. They may also be few or numerous, deep or shallow, spreading or restricted, fibrous or non-fibrous. The structure of the root thus becomes important in distinguishing species.

The stem.

Stem or trunk: The unbranched main axis of the plant above ground.
Branches or arms: Main divisions of the trunk.
Head: The region from which branches arise.
Old wood: Parts of the vine older than one year.
Canes: Wood of the current season.
Spurs: Short pieces of the bases of canes; usually one or two nodes with a bud each.
Renewal spurs: Spurs left to bear canes the following year.
Shoots: Newly developed succulent stems with their leaves.
Fruit-shoots: Flower and fruit-bearing shoots.
Wood-shoots: Shoots which bear leaves only.
Laterals: Secondary shoots arising from main shoots.
Water sprouts: Shoots arising from adventitious buds.
Suckers: Shoots arising from below ground.
Nodes: Joints in the stem from which leaves are or may be borne.
Internodes: The part between two nodes.
Diaphragm: The woody tissue which interrupts the pith at the node.
Bloom: The powdery coating on the cane.
Tendril: The coiled, thread-like organ by which the vine grasps an object and clings to it.

Species of grapes have very characteristic vines. A glance at a vine enables one to tell the European grape from any of the American grapes; so, also, one is able to distinguish most of the American species by the aspect of the vine. Many varieties of any species of grape are readily told by the size and habits of the plant. Size of vine is rather more variable than other gross characters because of the influence of environment, such as food, moisture, light, isolation and pests; yet, size in a plant or the parts of a plant is a very reliable character when proper allowances are made for environment.

The degree of hardiness is a very important diagnostic character in determining both species and varieties of grapes and very largely indicates their value for the vineyard. Thus, the varieties of the European grape are less hardy than the peach, while our American Labruscas and Vulpinas are as hardy as the apple. The range of varieties as to hardiness falls within that of the species, and cultivated varieties hardier than the wild grape are not found. Grapes are designated in descriptions of varieties and species as hardy, half-hardy and tender.

Habit of growth varies but little with changing conditions and is thus an important means of distinguishing species and varieties and not infrequently stamps the variety as fit or unfit for the vineyard. Habit of growth gives aspect to the vine. Thus, a vine may be upright, drooping, horizontal, stocky, straggling, spreading, dense or open. The vine may grow rapidly or slowly and may be long-lived or short-lived; the trunk may be short and stocky or long and slender. These several characters largely determine whether a vine is manageable in the vineyard. Productiveness, age of bearing and regularity of bearing are distinctive characters with cultivated grapes. The care given the vine influences these characters; yet all are helpful in identifying species and varieties and all must be considered by the grape-grower.

Immunity and susceptibility to diseases and insects are

most valuable diagnostic characters of species and varieties of grapes. Thus, species differ widely in resistance to phylloxera, the grape-louse, to the grape leaf-hopper, the flea-beetle, berry-moth, root-worm, powdery-mildew, downy-mildew, anthracnose and other insect and fungous troubles of this fruit.

The structure of the bark is an important distinguishing character for some species, but is of little importance in identifying the variety and has no economic value to the fruit-grower. In most species of grapes, the bark has distinct lenticels and on the old wood separates in long thin strips and fibers; but in two species from southeastern North America, the bark bears prominent lenticels and never shreds. Smoothness, color and thickness are other attributes of the bark to be noted.

Canes of different species vary greatly in total length and in length of internodes. They vary also in size, in number and in color, while the shape in some species is quite distinctive, being in some round, in others angular and in still others flattened. The direction of growth in canes, whether sinuous, straight or zigzag, is an important character. Nodes and internodes are indicative characters in some species, being more or less prominent, angular or flattened, while the internodes are long or short.

The diaphragm distinguishes several species of grapes. The cane contains a large pith and this in most species is interrupted by woody tissue, forming a diaphragm at the nodes. In the Rotundifolia grapes the diaphragm is absent, while in several other American species it is very thin and in still others quite thick. The character of the diaphragm is best observed in year-old canes. In studying the diaphragm, notice should be taken also of the pith, which is very variable in size.

Young shoots of the grape offer a ready means of distinguishing species and varieties through their color and the amount

and character of the pubescence. Shoots may be glabrous, pubescent or hairy and even spiny.

The tendril is one of the organs most used in determining species and varieties of grapes. In some species, as *V. Labrusca*, there is a tendril or an inflorescence opposite nearly every leaf, continuous tendrils. All other species have two leaves with a tendril opposite each and a third leaf without a tendril, intermittent tendrils. To study this organ it is necessary to have vigorous, healthy, typical canes. Tendrils may be long or short, stout or slender; simple, bifurcated or trifurcated; or smooth, pubescent or warty.

The number of inflorescences borne by species is an important character in some cases. All species, excepting *V. Labrusca*, average two inflorescences to a cane, but *V. Labrusca* may bear from three to six inflorescences, each in the place of a tendril opposite the leaf.

The bud.

Bud: An undeveloped shoot.
Fruit-bud: A bud in which a shoot bearing flowers originates.
Wood-bud: A bud in which a shoot bearing only leaves originates.
Latent bud: A bud which remains dormant for one or more seasons.
Adventitious bud: A bud arising elsewhere than the normal position at a node.
Eye: A compound bud.
Main bud: The central bud of an eye.
Secondary bud: The lateral bud of an eye.

Buds of different species of grapes vary greatly in time of opening as they do somewhat in varieties, so that the time the buds begin to swell is a fine mark of distinction. The angle at which the bud stands out from the branch is of some value in determining species. Differences in color, size, shape, position and amount of pubescence of buds must all be noted in describing grapes. The scales of the buds vary more or less in size and in thickness.

The flower.

Staminate: Having stamens and not pistils; a male flower.
Pistillate: Having pistils and not stamens; a female flower.
Diœcious: Said when the stamens are on one plant and the pistils on another.
Polygamous: Said when flowers on a plant are in part perfect (having both stamens and pistils) while others are staminate or pistillate.
Hermaphrodite: Said of a flower having both stamens and pistils.
Fertile: Said of a flower capable of bearing seed without pollen from another flower.
Sterile: Said of a flower without or with abortive pistils.
Perfect: Said of a flower having both stamens and pistils.
Imperfect: Said of a flower wanting either stamens or pistils.
Peduncle: The stalk of a flower-cluster.
Pedicel: The stalk of each particular flower.

The time of bloom is an easy mark of distinction between several species of grapes and helps to distinguish varieties in a species as well. Most species of grapes bear fertile flowers on one vine and sterile flowers on another and are, therefore, polygamous-diœcious. Sterile vines bear male flowers with abortive pistils so that, while they never produce fruits themselves, they usually assist in fertilizing others. Fertile flowers are capable of ripening fruits without cross-pollination. Vines with female flowers only are seldom found. In most species of the grape, plants with sterile flowers and those with complete flowers are found mixed in the wild state, but usually only the fertile plants have been selected for cultivation. Plants raised from seeds of any of the species, however, furnish many sterile vines.

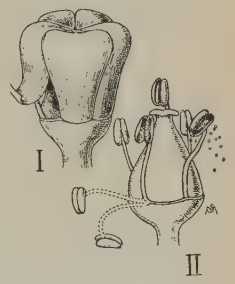

Fig. 53. The grape flower. I. Opening bud showing the way in which the cap becomes loosened at the base. II. Diagrammatic illustration of grape stamens.

The degree of fertility of blossoms is also a fine mark of distinction in species and varieties of the grape. Fertile vines are of two kinds in most species. The flowers on one kind are per-

fect hermaphrodites, while in the other kind the stamens are smaller and shorter than the pistil and eventually bent down and curved under. The two kinds of stamens are shown in Figs. 53 and 54. These may be called imperfect hermaphrodites since they are seldom as fruitful as the perfect hermaphrodites unless fertilized from another plant. Examined with

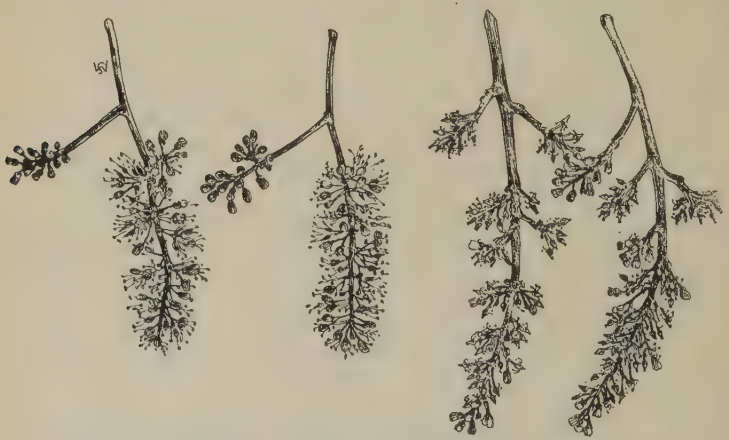

FIG. 54. Grape flowers. *Left*, upright stamens of Delaware; *right*, depressed stamens of Brighton.

a microscope, it is found that self-sterile plants usually bear abortive pollen and that the percentage of abortive pollen grains varies greatly in different varieties. The upright or depressed stamen does not always indicate the condition of the pollen, since there are many instances in which upright stamens bear impotent pollen and occasionally the depressed stamens bear perfect pollen.

The leaf.

Blade: The expanded portion of the leaf.
Lobe: The more or less rounded division of the leaf.
Sinus: The recess or bay between two lobes.

Petiole: The leaf-stalk.
Petiolar sinus: The sinus about the petiole.
Basal sinuses: The two sinuses toward the base of the blade.
Lateral sinuses: The two sinuses toward the apex of the blade.

The size, shape and color of the leaves are quite distinctive of species and more or less so of varieties, if allowances are made for variation due to environment. The lobing of leaves is a very uniform character in most species, some having lobes and others having entire leaves. The upper surface of the leaf in some species is smooth, glossy and shiny and in others is rough and dull. The lower surface shows similar variations and has, besides, varying amounts of pubescence, down and bloom. In some species the down resembles cobwebs. The number, size and shape of the lobes are important in distinguishing both varieties and species, as are also the petiolar, basal and lateral sinuses. As in most plants, the margins of the leaves, whether serrate, dentate or crenate, are often distinguishing characters. The petiole in different species varies from short to long and from stout to slender. Lastly, the time at which the leaves fall is often a good distinguishing mark.

The fruit.

Peduncle and pedicel: Defined as in flower.
Brush: The end of the pedicel projecting into the fruit
Base: The point of attachment of bunch or berry.
Apex: The point opposite the base.
Bloom: The powdery coating on the fruit.
Pigment: The coloring matter in the skin.
Quality: The combination of characters that makes grapes pleasant to the palate, sight, smell and touch.
Foxiness: The rancid taste and smell of some grapes which are similar to the effluvium of a fox.

Of all organs the fruit is most responsive to changed conditions and hence most variable. Yet the fruits furnish most valuable characters for determining both species and varieties. Size, shape, compactness and the number of clusters on a shoot

must be noted. Coming to the berry, size, shape, color, bloom, adherence of stigma to the apex and adhesion of fruit to the pedicel are all of value. Difference in adherence of the skin to the pulp separates European from all American grapes. The thickness, toughness, flavor and pigment of the skin have more or less value. The color, firmness, juiciness, aroma and flavor of the flesh, as well as its adherence to seed and skin, are valuable marks in describing grapes. All species and varieties are well distinguished by the time of ripening and by keeping quality. The color of the juice is a plain and certain dividing line between some species and many varieties.

The seed.

Beak: The narrow prolonged base of the seed.
Hilum: The scar left where the seed was attached to the seed-stalk.
Chalaza: The place where the seed-coats and kernel are connected.
Raphe: The line or ridge which runs from the hilum to the chalaza.

Seeds are accounted of much value in determining species. The size and weight of seed differ greatly in different species, as they do also in varieties of any one species. Thus, of native grapes, Labrusca has the largest and heaviest seeds and Vulpina has the smallest seed, while those of Æstivalis are of medium size and weight. The shape and color of seed offer distinguishing marks, while the size, shape and position of the raphe and chalaza furnish very certain marks of distinction in some species.

The Genus Vitis

The genus Vitis belongs to the vine family (Vitaceæ) in which most botanists also put the wood-vines (Ampelopsis), of which Virginia creeper is the best-known plant. The genus Cissus, to which belong many southern climbers, is combined with Vitis by some botanists. Vitis is separated from Ampelopsis and Cissus by marked differences in several organs, of which,

horticulturally at least, those in the fruit best serve to distinguish the group. Species of Vitis, with possibly one or two exceptions, bear pulpy edible fruits; species of Ampelopsis and Cissus bear fruits with pulp so scant that the berries are inedible. Vitis is further distinguished as follows: The plants are climbing or trailing, rarely shrubby, with woody stems and mostly with coiling, naked-tipped tendrils. The leaves are simple, palmately lobed, round-dentate or heart-shaped-dentate. The stipules are small, falling early. The flowers are polygamo-dicœcious (some plants with perfect flowers, others staminate with at most a rudimentary ovary), five-parted. The petals are separated only at the base and fall off without expanding. The disk is hypogynous with five nectariferous glands which are alternate with the stamens. The berry is globose or ovoid, few-seeded and pulpy. The seeds are pyriform and beak-like at the base.

Species of American Grapes

The number of species of grapes in the world depends on the arbitrary limits set for a species of this fruit, and knowledge of the genus is yet too meager to set these limits with certainty. Indeed, the men who have made grape species have seldom been able to outline the habitats of their groups with much certainty. In habitat, it should be said, grapes are confined almost wholly to temperate and subtropical regions. However, the grape-grower is not much concerned with species of grapes other than those that have horticultural value. Of these, in America, there are now ten more or less cultivated either for fruit or for stocks. The following descriptions of these ten species are adapted from the author's The Grapes of New York, published in 1908 by the state of New York (Chapter IV, pages 107–156).

CONSPECTUS OF CULTIVATED SPECIES OF VITIS

A. Skin of mature berry separating freely from the pulp.
B. Nodes without diaphragms; tendrils simple.
1. *V. rotundifolia.*
2. *V. Munsoniana.*
BB. Nodes with diaphragms; tendrils forked.
C. Leaves and shoots glabrous at maturity and without bloom; tendrils intermittent.
D. Leaves thin, light, bright green, generally glabrous below at maturity except perhaps in the axils of the veins with a long or at least a prominent point and usually long and sharp teeth or the edge even-jagged.
E. Leaves broader than long; petiolar sinus usually wide and shallow.
3. *V. rupestris.*
EE. Leaves ovate in outline; petiolar sinus usually medium to narrow.
4. *V. vulpina.*
DD. Leaves thick, dull colored or grayish-green, often holding some close, dull pubescence below at maturity, shoots and leaves nearly always more or less pubescent when young; the teeth mostly short . . . . . 5. *V. cordifolia.*
6. *V. Berlandieri.*
CC. Leaves rusty or white tomentose or glaucous blue below, thick or at least firm.
D. Leaves flocculent or cobwebby or glaucous below when fully grown . . . . . 7. *V. æstivalis.*
8. *V. bicolor.*
DD. Leaves densely tomentose or felt-like beneath throughout the season; covering white or rusty white.
E. Tendrils intermittent . . . . . 9. *V. candicans.*
EE. Tendrils mostly continuous.
10. *V. Labrusca.*
AA. Skin and pulp of mature berry cohering. (Old World.)
11. *V. vinifera.*

1. *Vitis rotundifolia*, Michx. Muscadine Grape. Bull Grape. Bullet Grape. Bushy Grape. Bullace Grape. Scuppernong. Southern Fox Grape.

Vine very vigorous, sometimes, when without support, shrubby and only three or four feet high; when growing in the shade often send-

ing down aërial roots. Wood hard, bark smooth, not scaling, with prominent warty lenticels; shoots short-jointed, angled, with fine scurfy pubescence; diaphragms absent; tendrils intermittent, simple. Leaves small, broadly cordate or roundish; petiolar sinus wide, shallow; margin with obtuse, wide teeth; not lobed; dense in texture, light green color, glabrous above, sometimes pubescent along veins below. Cluster small (6–24 berries), loose; peduncle short; pedicels short, thick. Berries large, globular or somewhat oblate, black or greenish-yellow; skin thick, tough and with a musky odor; pulp tough; ripening unevenly and dropping as soon as ripe. Seeds flattened, shallowly and broadly notched; beak very short; chalaza narrow, slightly depressed with radiating ridges and furrows; raphe a narrow groove. Leafing, flowering and ripening fruit very late.

The habitat of this species is southern Delaware, west through Tennessee, southern Illinois, southeastern Missouri, Arkansas (except the northwestern portions), to Grayson County, Texas, as a northern and western boundary, to the Atlantic Ocean and the Gulf on the east and south. It becomes rare as one approaches the western limit but is common in many sections of the great region outlined above, being most abundant on sandy, well-drained bottom lands and along river banks and in swampy, thick woodlands and thickets. The climate most suitable for Rotundifolia is that in which cotton grows, and it thrives best in the lower portions of the cotton-belt of the United States.

The fruit of Rotundifolia is very characteristic. The skin is thick, has a leathery appearance, adheres strongly to the underlying flesh and is marked with lenticel-like russet dots. The flesh is more or less tough but the toughness is not localized around the seed as in the case of Labrusca. The fruit and most of the varieties of the species are characterized by a strong, musky aroma and are lacking in sugar and acid. Some varieties yield over four gallons of must to the bushel. Wine-makers are divided in opinion as to its value for wine-making, but at present the most promising outlook for Rotundifolia varieties is as wine, grape-juice and culinary grapes. Rotundifolia does not produce fruit suitable for shipping as dessert grapes chiefly because the berries ripen unevenly and when ripe drop from the

cluster. The common method of gathering the fruit of this species is to shake the vines at intervals so that the ripe berries drop on sheets spread below the vines. The juice which exudes from the point where the stem is broken off causes the berries to become smeared and gives them an unattractive appearance. Owing, however, to the tough skin, the berries do not crack as badly as other grapes would under the same conditions, but nevertheless they are not adapted to long-distance shipments. Under reasonably favorable conditions, the vines attain great age and size and when grown on arbors, as they often are, and without pruning, they cover a large area.

Rotundifolia is remarkably resistant to the attacks of all insects and to fungal diseases. The phylloxera do not attack its roots and it is considered as resistant as any other, if not the most resistant of all American species. The vines are grown from cuttings only with difficulty and this prevents the use of this species as a resistant stock. However, under favorable circumstances, and with skillful handling, this is a successful method of propagation. Under unfavorable circumstances, or when only a few vines are desired, it is better to depend on layers. As a stock upon which to graft other vines, this species has not been a success. There is great difficulty in crossing Rotundifolia with other species, but several Rotundifolia hybrids are now on record.

2. *Vitis Munsoniana*, Simpson. Florida Grape. Everbearing grape. Bird Grape. Mustang Grape of Florida.

Vine slender, usually running on the ground or over low bushes. Canes angular; internodes short; tendrils intermittent, simple. Leaves smaller and thinner than Rotundifolia and rather more circular in outline; not lobed; teeth open and spreading; petiolar sinus V-shaped; both surfaces smooth, rather light green. Cluster with more berries but about the same size as in Rotundifolia. Berry one-third to one-half the diameter, with thinner and more tender skin; black, shining; pulp less solid, more acid and without muskiness.

Seeds about one-half the size of those of Rotundifolia, similar in other respects. Leafing, flowering and ripening fruit very late.

The habitat of *V. Munsoniana* is central and southern Florida and the Florida Keys. It extends south of the habitat of Rotundifolia and blends into this species at their point of meeting. Munsoniana appears to be a variation of Rotundifolia, fitted to subtropical conditions. It is tender, not enduring a lower temperature than zero. In the matter of multiplication, it differs from *V. rotundifolia* in that it can be propagated readily from cuttings. Like Rotundifolia it is resistant to phylloxera.

3. *Vitis rupestris*, Scheele. Mountain Grape. Rock Grape. Bush Grape. Sand Grape. Sugar Grape. Beach Grape.

A small, much branched shrub or, under favorable circumstances, climbing. Diaphragm thin; tendrils few, or if present, weak, usually deciduous. Leaves small; young leaves frequently folded on midrib; broadly cordate or reniform, wider than long, scarcely ever lobed, smooth, glabrous on both surfaces at maturity; petiolar sinus wide, shallow; margin coarsely toothed, frequently a sharp, abrupt point at terminal. Cluster small. Berries small, black or purple-black. Seeds small, not notched; beak short, blunt; raphe distinct to indistinct, usually showing as a narrow groove; chalaza pear-shaped, sometimes distinct, but usually a depression only. Leafing, blossoming and ripening early.

This species is an inhabitant of southwestern Texas, extending eastward and northward into New Mexico, southern Missouri, Indiana and Tennessee to southern Pennsylvania and the District of Columbia. Its favorite places are gravelly banks and bars of mountain streams or the rocky beds of dry watercourses. This species is rather variable both in type and growth. It was introduced into France at about the same time as Vulpina, and the French vineyardists selected the most vigorous and healthy forms for grafting stock. These pass under the various names of Rupestris Mission, Rupestris du Lot, Rupestris Ganzin, Rupestris Martin, Rupestris St. George

and others. In France, these varieties have given particularly good results on bare, rocky soils with hot, dry exposures. In California, Rupestris does not flourish in dry locations, and as it suckers profusely and does not take the graft as readily as Vulpina and Æstivalis, it is not largely propagated.

The clusters of fruit are small, with berries about the size of a currant and varying from sweet to sour. The berry is characterized by much pigment under the skin. The fruit has a sprightly taste wholly free from any disagreeable foxiness. Rupestris under cultivation is said to be very resistant to rot and mildew of the foliage. The vine is considered hardy in the Southwest. The attention of hybridizers was attracted to this species over thirty years ago, and various hybrids have been produced of great promise for grape-breeding. The root system of Rupestris is peculiar in that the roots penetrate at once deeply into the ground instead of extending laterally as in other species. Like those of Vulpina, the roots are slender, hard and resistant to phylloxera. The species is easily propagated by cuttings. The vines bench-graft readily but are difficult to handle in field grafting.

4. *Vitis vulpina,* Linn. (*V. riparia,* Michx.). Winter Grape. River Grape. Riverside Grape. Riverbank Grape. Sweet-scented Grape.

Vine very vigorous, climbing. Shoots cylindrical or angled, usually smooth, slender; diaphragms thin; tendrils intermittent, slender, usually bifid. Leaves with large stipules; leaf-blade large, thin, entire, three- or lower ones often five-lobed; sinuses shallow, angular; petiolar sinus broad, usually shallow; margin with incised, sharply serrate teeth of variable size; light green, glabrous above, glabrous but sometimes pubescent on ribs and veins below. Cluster small, compact, shouldered; peduncle short. Berries small, black with a heavy blue bloom. Seeds two to four, small, notched, short, plump, with very short beak; chalaza narrowly oval, depressed, indistinct; raphe usually a groove, sometimes distinct. Very variable in flavor and time of ripening.

Vulpina is the most widely distributed of any American species of grape. It has been discovered in parts of Canada north of Quebec and from thence southward to the Gulf of Mexico. It is found from the Atlantic coast westward, most botanists say, to the Rocky Mountains. Usually it grows on river banks, on islands or in upland ravines. Vulpina has always been considered of great promise in the evolution of American grapes. It can hardly be said that it has fulfilled expectations, there probably being no pure variety of this species of more than local importance, and the results of hybridizing it with other species have not been wholly successful. Attention was early turned to Vulpina because of the qualities presented by the vine rather than those of the fruit, particularly its hardiness and vigor. However, both of these qualities are rather variable, although it is only reasonable to suppose that in such a widely distributed species, plants found in a certain region would have adapted themselves to the conditions there present; thus, it should be expected that the northern plants would be more hardy than those from the South, and that the western prairie forms would be more capable of resisting drouth than those from humid regions. It is, consequently, impossible to say what conditions best suit this species. It may be said, however, that Vulpina is adapted to a great variety of soils and locations; vines have withstood a temperature of 40 to 60 degrees below zero and they show equal ability in withstanding the injurious effects of high temperatures in the summer. On account of its habit of early blooming, the blossoms sometimes suffer from late frosts in the spring.

While Vulpina is not a swamp grape and is not found growing under swampy conditions, it is fond of water. In the semi-arid regions always, and in humid regions usually, it is found growing along the banks of streams, in ravines, on the islands of rivers and in wet places. It is not nearly so capable of withstanding drouth as Rupestris. Vulpina likes a rather rich soil,

but in France has been found to do poorly on limestone land and calcareous marls. The French tell us, however, that this is a characteristic of all our American grapes, and that Vulpina is more resistant to the injurious effects of an excess of lime than either Rupestris or Æstivalis.

The fruit of Vulpina is usually small, there being occasional varieties of medium size or above. The clusters are of medium size and, if judged from the standpoint of number of berries, might frequently be called large. The flavor is usually sharply acid but free from foxiness or any disagreeable wild taste. If eaten in quantity, the acidity is likely to affect the lips and end of the tongue. When the acidity is somewhat ameliorated, as in the case of thoroughly ripe or even over-ripe and shriveled fruit, the flavor is much liked. The flesh is neither pulpy nor solid and dissolves in the mouth and separates readily from the seed. The must of Vulpina is characterized by an average amount of sugar, varying considerably in the fruit from different vines, and by an excess of acid.

Vulpina is very resistant to phylloxera, the roots are small, hard, numerous and branch freely. The roots feed close to the surface and do not seem to be well adapted to forcing their way through heavy clays. Vulpina grows readily from cuttings and makes a good stock for grafting, its union with other species being usually permanent. When Vulpinas were first sent to France to be used as a stock in reconstituting the French vineyards, it was found that many of the vines secured from the woods were too weak in growth to support the stronger-growing Viniferas. On this account the French growers selected the more vigorous forms of the Vulpinas, to which they gave varietal names, as Vulpina Gloire, Vulpina Grand Glabre, Vulpina Schribner, Vulpina Martin and others. With these selected Vulpinas, the graft does not outgrow the stock. Vulpina is less resistant to black-rot than Æstivalis but somewhat more resistant than Labrusca. The foliage is rarely attacked by mildew. One of

the chief failings of this species is the susceptibility of the leaves to the attack of the leaf-hopper. The Vulpinas are generally late in ripening; the fruit is better in quality in long seasons and should be left on the vines as late as possible.

5. *Vitis cordifolia*, Michx. Winter Grape. Frost Grape. Fox Grape. Chicken Grape. Heart-leaved Vitis. Possum Grape. Sour Winter Grape.

Vine very vigorous, climbing. Shoots slender; internodes long, angular, usually glabrous, sometimes pubescent; diaphragms thick; tendrils intermittent, long, usually bifid. Leaves with short, broad stipules; leaf-blade medium to large, cordate, entire or indistinctly three-lobed; petiolar sinus deep, usually narrow, acute; margin with coarse angular teeth; point of leaf acuminate; upper surface light green, glossy, glabrous; glabrous or sparingly pubescent below. Clusters medium to large, loose, with long peduncle. Berries numerous and small, black, shining, little or no bloom. Seeds medium in size, broad, beak short; chalaza oval or roundish, elevated, very distinct; raphe a distinct, cord-like ridge. Fruit sour and astringent and frequently consisting of little besides skins and seeds. Leafing, flowering and ripening fruit very late.

Owing to the fact that Cordifolia and Vulpina have been badly confused, the limits of the habitat of this species are difficult to determine. The best authorities give the northern limit as New York or the Great Lakes. The eastern limit is the Atlantic Ocean and the southern limit, the Gulf of Mexico. It extends westward, according to Engelmann, to the western limits of the wooded portion of the Mississippi Valley in the North, and, according to Munson, to the Brazos River, Texas, in the South. It is found along creeks and river banks sometimes mixed with Vulpina, having about the same soil adaptations as that species. It is a very common species in the middle states and frequently grows on limestone soils, but is not indigenous to such soils.

Cordifolia makes a good stock for grafting, being vigorous and forming a good union with most of our cultivated grapes.

It is seldom used for this purpose, however, on account of the difficulty of propagating it by means of cuttings. For the same reason vines of it are seldom found in cultivation.

6. *Vitis Berlandieri,* Planch. Mountain Grape. Spanish Grape. Fall Grape. Winter Grape. Little Mountain Grape.

Vine vigorous, climbing; shoots more or less angled and pubescent; pubescence remaining only in patches on mature wood; canes mostly with short internodes; diaphragms thick; tendrils intermittent, long, strong, bifid or trifid. Leaves with small stipules; leaf-blade large, broadly cordate, notched or shortly three-lobed; petiolar sinus rather open, V- or U-shaped, margin with broad but rather shallow teeth, rather dark glossy green above, grayish pubescence below when young; becoming glabrous and even glossy except on ribs and veins, when mature. Clusters large, compact, compound, with long peduncle. Berries small, black, with thin bloom, juicy, rather tart but pleasant tasting when thoroughly ripe. Seeds few, small, short, plump, oval or roundish, with short beak; chalaza oval or roundish, distinct; raphe narrow, slightly distinct to indistinct. Leafing, flowering and ripening fruit very late.

Berlandieri is a native of the limestone hills of southwest Texas and adjacent Mexico. It grows in the same region with *V. monticola,* but is less restricted locally, growing from the tops of the hills down and along the creek bottoms of these regions. Its great virtue is that it withstands a soil largely composed of lime, being superior to all other American species in this respect. This and its moderate degree of vigor have recommended it to the French growers as a stock for their calcareous soils. The roots are strong, thick, and very resistant to phylloxera. It is propagated by cuttings with comparative ease, but its varieties are variable, some not rooting at all easily. While the fruit of this species shows a large cluster, the berries are small and sour, and Berlandieri is not regarded as having promise for culture in America.

7. *Vitis æstivalis,* Michx. Blue Grape. Bunch Grape. Summer Grape. Little Grape. Duck-shot Grape. Swamp Grape. Chicken Grape. Pigeon Grape.

Vine very vigorous, shoots pubescent or smooth when young; diaphragms thick; tendrils intermittent, usually bifid. Leaves with short, broad stipules; leaf-blade large, thin when young but becoming thick; petiolar sinus deep, usually narrow, frequently overlapping; margin rarely entire, usually three- to five-lobed; teeth dentate, shallow, wide; upper surface dark green; lower surface with more or less reddish or rusty pubescence which, in mature leaves, usually shows in patches on the ribs and veins; petioles frequently pubescent. Clusters long, not much branched, with long peduncle. Berries small, with moderate amount of bloom, usually astringent. Seeds two to three, of medium size, plump, smooth, not notched; chalaza oval, distinct; raphe a distinct cord-like ridge. Leafing and ripening fruit late to very late.

The division of the original species has reduced the habitat materially, confining it to the southeastern part of the United States from southern New York to Florida and westward to the Mississippi River. Æstivalis grows in thickets and openings in the woods and shows no such fondness for streams as Vulpina, or for thick timber as Labrusca, but is generally confined to uplands. Under favorable circumstances, the vines grow to be very large. Æstivalis is preëminently a wine grape. The fruit usually has a tart, acrid taste, due to the presence of a high percentage of acid, but there is also a large amount of sugar, the scale showing that juice from this species has a much higher percentage of sugar than the sweeter-tasting Labruscas. The wine made from varieties of Æstivalis is very rich in coloring matter and is used by some European vintners to mix with the must of European sorts in order to give the combined product a higher color. The berries are destitute of pulp, have a comparatively thin, tough skin and a peculiar spicy flavor. The berries hang to the bunch after becoming ripe much better than do those of Labrusca.

This species thrives in a lighter and shallower soil than Labrusca and appears to endure drought better, although not equaling in this respect, either Vulpina or Rupestris. The French growers report that Æstivalis is very liable to chlorosis

on soils which contain much lime. The leaves are never injured by the sun and they resist the attacks of insects, such as leaf-hoppers. better than any other American species under cultivation. Æstivalis is rarely injured by black-rot or mildew, according to American experience, but French growers speak of its being susceptible to both. The hard roots of Æstivalis enable it to resist phylloxera, and varieties with any great amount of the blood of this species are seldom seriously injured by this insect. An objection to Æstivalis, from a horticultural standpoint, is that it does not root well from cuttings. Many authorities speak of it as not rooting at all from cuttings, but this is an over-statement of the facts, as many of the wild and cultivated varieties are occasionally propagated in this manner, and some southern nurseries, located in particularly favorable situations, make a practice of propagating it by this method. Varieties of this species bear grafting well, especially in the vineyard.

Vitis æstivalis Lincecumii, Munson. Post-oak Grape. Pine-wood Grape. Turkey Grape.

Vine vigorous, sometimes climbing high upon trees, sometimes forming a bushy clump from two to six feet high; canes cylindrical, much rusty wool on shoots; tendrils intermittent. Leaves very large, almost as wide as long; entire or three-, five-, or rarely seven-lobed; lobes frequently divided; sinuses, including petiolar sinus, deep; smooth above, and with more or less rusty pubescence below. (The north-Texas, southwestern Missouri and northern Arkansas form shows little or no pubescence but has fine prickly spines at base of shoots and shows much blue bloom on shoots, canes and the under side of the leaves.) Fruit small to large, usually larger than typical Æstivalis, usually black, with heavy bloom. Seeds larger than Æstivalis, pear-shaped; chalaza roundish.

Lincecumii inhabits the eastern half of Texas, western Louisiana, Oklahoma, Arkansas and southern Missouri on high sandy land, frequently climbing post-oak trees, hence the name, post-oak grape, by which it is locally known.

Lincecumii has attracted considerable attention through the work of H. Jaeger and T. V. Munson in domesticating it, both of whom considered it one of the most, if not the most, promising form from which to secure cultivated varieties for the Southwest. The qualities which recommend it are: First, vigor; second, capacity to withstand rot and mildew; third, hardiness and capacity to endure hot and dry summers without injury; fourth, the large cluster and berry which were found on certain of the wild vines. The fruit is characteristic because of its dense bloom, firm, yet tender texture and peculiar flavor. The cultivated varieties have given satisfaction in many sections of the Central Western and Southern states. Like Æstivalis, it is difficult to propagate from cuttings.

The north-Texas glaucous form of this variety mentioned in the technical description above is the *V. æstivalis glauca* of Bailey. This is the type of Lincecumii that Munson has used in breeding work.

Vitis æstivalis Bourquiniana, Bailey. Southern Æstivalis.

Bourquiniana differs chiefly from the type in having thinner leaves; the shoots and under side of the leaves are only slightly reddish-brown in color; the pubescence usually disappears at maturity; the leaves are more deeply lobed than is common in Æstivalis; and the fruit is larger, sweeter and more juicy. Bourquiniana is known only in cultivation. The name was given by Munson, who ranks the group as a species. He includes therein many southern varieties, the most important of which are: Herbemont, Bertrand, Cunningham and Lenoir, grouped in the Herbemont section; and Devereaux, Louisiana and Warren, in the Devereaux section. Munson has traced the history of this interesting group and states that it was brought from southern France to America over one hundred fifty years ago by the Bourquin family of Savannah, Georgia. Many botanists are of the opinion

that Bourquiniana is a hybrid. The hybrid supposition is corroborated to a degree by the characters being more or less intermediate between the supposed parent species, and also by the fact that up to date no wild form of Bourquiniana has been found. The only northern variety of any importance supposed to have Bourquiniana blood is the Delaware, and in this variety only a fraction of Bourquiniana blood is presumably present. Bourquiniana can be propagated from cuttings more easily than the typical Æstivalis but not so readily as Labrusca, Vulpina or Vinifera. Many of the varieties of Bourquiniana show a marked susceptibility to mildew and black-rot; in fact, the whole Herbemont group is much inferior in this respect to the Norton group of Æstivalis. The roots are somewhat hard, branch rather freely and are quite resistant to phylloxera.

8. *Vitis bicolor*, Le Conte. Blue Grape. Northern Summer Grape. Northern Æstivalis.

Vine vigorous, climbing; shoots cylindrical or angled, with long internodes, generally glabrous, usually showing much blue bloom, sometimes spiny at base; diaphragms thick; tendrils intermittent, long, usually bifid. Leaves with short, broad stipules; leaf-blade large; roundish-cordate, usually three-, sometimes on older growth shallowly five-lobed, rarely entire; petiolar sinus variable in depth, usually narrow; margin irregularly dentate; teeth acuminate; glabrous above, usually glabrous below and showing much blue bloom which sometimes disappears late in the season; young leaves sometimes pubescent; petioles very long. Cluster of medium size, compact, simple; peduncle long. Berries small, black with much bloom, acid but pleasant tasting when ripe. Seeds small, plump, broadly oval, very short beak; chalaza oval, raised, distinct; raphe distinct, showing as a cord-like ridge.

Bicolor is readily distinguished from Æstivalis by the absence of the reddish pubescence and by blooming slightly later. The habitat of Bicolor is to the north of that of Æstivalis, occupying the northeastern, whereas Æstivalis occupies the

southeastern quarter of the United States. Like Æstivalis, this species is not confined to streams and river banks but frequently grows on higher land also. It is found in north Missouri, Illinois, southwestern Wisconsin, Indiana, southern Michigan, Ohio, Kentucky, Pennsylvania, New York, southwestern Ontario, New Jersey and Maryland and by some botanists is reported as far south as western North Carolina and west Tennessee.

The horticultural characters of Bicolor are much the same as those of Æstivalis. About the only points of difference are that it is much hardier (some of the Wisconsin vines stand a temperature as low as 20 degrees below zero); it is said to be slightly less resistant to mildew and more resistant to phylloxera. Like Æstivalis, Bicolor does not thrive on limy soils and it is difficult to propagate from cuttings. The horticultural possibilities of Bicolor are probably much the same as those of Æstivalis, although many think it to be more promising for the North. It is as yet cultivated but little. Its chief defect for domestication is the small size of the fruit.

9. *Vitis candicans,* Englem. Mustang Grape.

Vine very vigorous, climbing; shoots and petioles densely wooly, whitish or rusty; diaphragm thick; tendrils intermittent. Leaves with large stipules; blade small, broadly cordate to reniform-ovate, entire or in young shoots and on young vines and sprouts usually deeply three- to five-, or even seven-lobed; teeth shallow, sinuate; petiolar sinus shallow, wide, sometimes lacking; dull, slightly rugose above, dense whitish pubescence below. Clusters small. Berries medium to large, black, purple, green, or even whitish, thin blue bloom or bloomless. Seeds usually three or four, large, short, plump, blunt, notched; chalaza oval, depressed, indistinct; raphe a broad groove.

The habitat of this grape extends from southern Oklahoma, as a northern limit, southwesterly into Mexico. The western boundary is the Pecos River. It is found on dry, alluvial, sandy or limestone bottoms or on limestone bluff lands and is

said to be especially abundant along upland ravines. Candicans grows well on limestone lands, enduring as much as 60 per cent of carbonate of lime in the soil. The species blooms shortly before Labrusca and a week later than Vulpina. It requires the long hot summers of its native country and will stand extreme drouth but is not hardy to cold, 10 or 15 degrees below zero killing the vine outright unless protected; and a lesser degree of cold injuring it severely. The berries, which are large for wild vines, have thin skins under which there is a pigment which gives them, when first ripe, a fiery, pungent taste but which partly disappears with maturity. The berries are very persistent, clinging to the pedicel long after ripe. Candicans is difficult to propagate from cuttings. Its roots resist phylloxera fairly well. It makes a good stock for Vinifera vines in its native country, but owing to the difficulty of propagation is seldom used for that purpose. In the early days of Texas, it was much used for the making of wine but as it is deficient in sugar, and as the must retains the acrid, pungent flavor, it does not seem to be well adapted for this purpose. It is not regarded as having great promise for southern horticulture and certainly has none for the North.

10. *Vitis Labrusca,* Linn. Fox-Grape.

Vine vigorous, stocky, climbing; shoots cylindrical, densely pubescent; diaphragms medium to thick; tendrils continuous, strong, bifid or trifid. Leaves with long, cordate stipules; leaf-blade large, thick, broadly cordate or round; entire or three-lobed, frequently notched; sinuses rounded; petiolar sinus variable in depth and width, V-shaped; margin with shallow, acute-pointed, scalloped teeth; upper surface rugose, dark green, on young leaves pubescent, becoming glabrous when mature; lower surface covered with dense pubescence, more or less whitish on young leaves, becoming dun-colored when mature. Clusters more or less compound, usually shouldered, compact; pedicels thick; peduncle short. Berries round; skin thick, covered with bloom, with strong musky or foxy aroma. Seeds two to four, large, distinctly notched, beak short; chalaza oval in shape indistinct, showing as a depression; raphe, a groove.

Labrusca is indigenous to the eastern part of North America, including the region between the Atlantic Ocean and the Alleghany Mountains. It is sometimes found in the valleys and along the western slopes of the Alleghanies. Many botanists say it never occurs in the Mississippi Valley. In the first-named area it ranges from Maine to Georgia. It has the most restricted habitat of any American species of horticultural importance, being much exceeded in extent of territory by *V. rotundifolia*, *V. æstivalis* and *V. vulpina*.

Labrusca has furnished more cultivated varieties, either pure-breeds or hybrids, than all other American species together. The reason for this is partly, no doubt, that it is native to the portion of the United States first settled and is the most common grape in the region where agriculture first advanced to the condition at which fruits were desired. This does not wholly account for its prominence, however, which must be sought elsewhere. In its wild state, Labrusca is probably the most attractive to the eye of any of our American grapes on account of the size of its fruit, and this undoubtedly turned the attention of those who were early interested in the possibilities of American grape-growing to this species rather than to any other.

The southern Labrusca is quite different from the northern form and demands different conditions for its successful growth; in the North, at least two types of the species may be distinguished. Vines are found in the woods of New England which resemble Concord very closely in both vine and fruit, excepting that the grapes are much smaller in size and more seedy. There is also the large-fruited, foxy Labrusca, usually with reddish berries, represented by such cultivated varieties as Northern Muscadine, Dracut Amber, Lutie and others. Labrusca is peculiar amongst American grapes in showing black-, white- and red-fruited forms of wild vines growing in the woods. Because of this variability, it is im-

possible to give the exact climatic and soil conditions best adapted to the species. It is reasonable to suppose, however, that the ideal conditions for this species under cultivation are not widely different from those prevailing where the species is indigenous. In the case of Labrusca, this means that it is best adapted to humid climates, and that the temperature desired varies according to whether the variety comes from the southern or northern form of the species.

The root system of Labrusca does not penetrate the soil deeply, but the vine is said to succeed better in deep and clayey soils than Æstivalis. It endures an excess of water in the soil, and, on the other hand, requires less water for successful growing than Æstivalis or Vulpina. In spite of its ability to withstand clayey soils, it seems to prefer loose, warm, well-drained sandy lands to all others. The French growers report that all varieties of this species show a marked antipathy to a limestone soil, the vines soon becoming affected with chlorosis when planted in soils of this nature. In corroboration of this, it may be said that Labrusca is not often found wild in limestone soils. The Labruscas succeed very well in the North and fairly well in the Middle West as far south as Arkansas, where they are raised on account of their fruit qualities, for here the vines are not nearly so vigorous and healthy as are those of other species. In Alabama, they are reported to be generally unsatisfactory, and in Texas the vines are short-lived, unhealthy, and generally unsatisfactory, particularly in the dry regions. There are some exceptions to this, as for instance, in the Piedmont region of the Carolinas, where, owing to elevation or other causes, the climate of a southern region is semi-northern in its character.

The grapes of Labrusca are large and usually handsomely colored. The skin is thick, covering a layer of adhering flesh, which gives the impression of its being thicker than it actually is; the berry is variable in tenderness, sometimes tough, but

in many cultivated varieties is so tender that it cracks in transportation. The skin of this species usually has a peculiar aroma, generally spoken of as foxy, and a slightly acid, astringent taste. Beneath the skin there is a layer of juicy pulp, quite sweet and never showing much acidity in ripe fruit. The center of the berry is occupied by rather dense pulp, more or less stringy, with considerable acid close to the seeds. Many object to the foxy aroma of this species, but, nevertheless, the most popular American varieties are more or less foxy. Analyses show that the fruit is usually characterized by a low percentage of sugar and acid, the very sweet-tasting fox-grapes not showing as high a sugar-content as some of the disagreeably tart Æstivalis and Vulpina sorts. This, in addition to the foxiness which furnishes an excess of aroma in the wine, has prevented Labrusca varieties from becoming favorites with the wine-makers, but most of the grape-juice now manufactured is made from them.

In addition to the characters enumerated, it may be said that Labrusca submits well to vineyard culture, is fairly vigorous and generally quite productive. It grows readily from cuttings and in hardiness is intermediate between Vulpina, the hardiest of our American species, and Æstivalis. The roots are soft and fleshy (for an American grape) and in some localities subject to attacks of phylloxera. None of the varieties of Labrusca has ever been popular in France on this account. In the wild vines, the fruit is inclined to drop when ripe. This defect is known as "shattering" or "shelling" among grape-growers and is a serious weakness in some varieties. Labrusca is said to be more sensitive in its wild state to mildew and black-rot than any other American species, but the evidence on this point does not seem to be wholly conclusive. In the South, and in some parts of the Middle West, the leaves of all varieties of Labrusca sunburn and shrivel in the latter part of the summer. The vines do not endure drouth as well as Æstivalis or Vulpina and not nearly so well as Rupestris.

11. *Vitis vinifera*, Linn.

Vine variable in vigor, not so high climbing as most American species; tendrils intermittent. Leaves round-cordate, thin, smooth, and when young, shining, frequently more or less deeply three-, five-, or even seven-lobed; usually glabrous but in some varieties the leaves and young shoots are hairy and even downy when young; lobes rounded or pointed; teeth variable; petiolar sinus deep, narrow, usually overlapping. Berries very variable in size and color, usually oval though globular. Seeds variable in size and shape, usually notched at upper end and characterized always by a bottle-necked, elongated beak; chalaza broad, usually rough, distinct; raphe indistinct. Roots large, soft and spongy.

The original habitat of the species is not positively known. De Candolle, as noted in the first part of this work, considered the region about the Caspian Sea as the probable habitat of the Old World grape. There is but little doubt that the original home of *V. vinifera* is some place in western Asia.

Neither American nor European writers agree as to the climate desired by Vinifera, for the reason, probably that all of the varieties in this variable species do not require the same climatic conditions. There are certain phases of climate, however, that are well agreed on: the species requires a warm, dry climate and is more sensitive to change of temperature than American species. Varieties of this species can be grown successfully in a wide variety of soils, being much less particular as to soils than American sorts.

Certain characters of the fruit of this species are not found in any American forms: First, the skin, which is attached very closely to the flesh and which is never astringent or acid, can be eaten with the fruit; second, the flesh is firm, yet tender, and uniform throughout, differing in this respect from all American grapes which have a sweet, watery and tender pulp close to the skin with a tough and more or less acid core at the center; third, the flavor has a peculiarly sprightly quality known as vinous; fourth, the berry adheres firmly to the

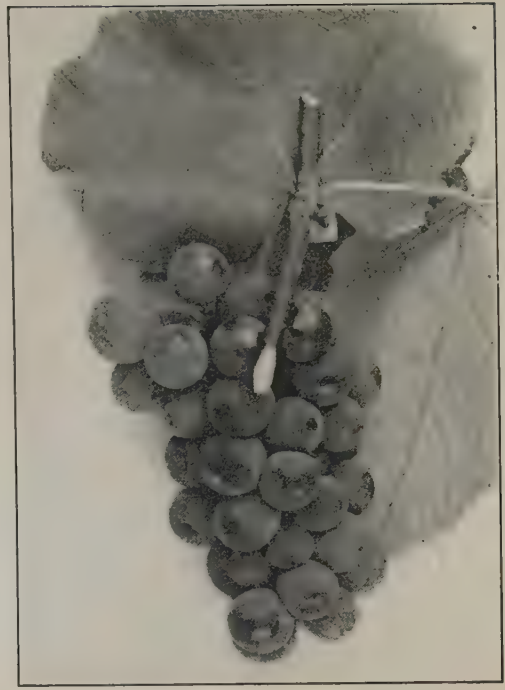

PLATE XXIII. — Lutie ($\times \frac{1}{2}$).

Pocklington ($\times \frac{1}{2}$).

pedicel, the fruit seldom "shattering" or "shelling" from the cluster.

In the various hybrids that have been made between American and Vinifera varieties, it is usually found that the desirable qualities of Vinifera are inherited in about the same proportion as the undesirable ones. The fruit is improved in the hybrid but the vine is weakened; quality is usually purchased at the expense of hardiness and disease-resisting power. Vinifera may be grown very readily from cuttings.

CHAPTER XVIII

VARIETIES OF GRAPES

NATURE has expended her bounties in fullest measure for the vineyard. More than 2000 varieties of grapes are described in American viticultural literature, and twice as many more find mention in European treatises on the vine. Few other fruits offer the novelties given the grape in flavors, aromas, sizes, colors and uses. The vineyard, then, to fulfill commercial potentialities, should supply grapes throughout the whole season, and of the several colors and flavors and for all uses. A prime requisite for a vineyard being well-selected varieties, an assortment of all kinds and for all places in America is here described.

ACTONI

(Vinifera)

Actoni is a table-grape of the Malaga type which ripens at Geneva, New York, late in October, too late for the average season in the East but worth trying in favorable locations. It is grown in California but is not a favorite sort. The following brief description is made from fruit grown at Geneva:

Clusters large, shouldered, tapering, loose; berries medium to very large, long-oval to oval, clear green yellow; flesh crisp, firm; flavor sweet; quality good.

Agawam

(Labrusca, Vinifera)

Randall, Rogers No. 15

The qualities commending Agawam are large size and attractive appearance of bunch and berry; rich, sweet aromatic flavor; vigor of vine; and capacity for self-fertilization. For a grape having its proportion of European parentage, the vine is vigorous, hardy and productive. The chief defects in fruit are a thick and rough skin, coarse, solid texture of pulp and foxy flavor. The vine is susceptible to the mildews and in many localities does not yield well. Although Agawam ripens soon after Concord, it can be kept much longer and even improves in flavor after picking. The vines prefer heavy soils, doing better on clay than on sand or gravel. This is one of the grapes grown by E. S. Rogers, Salem, Massachusetts. It was introduced as No. 15 but in 1861 was given the name it now bears.

Vine vigorous, hardy, productive. Canes thick, dark brown; nodes enlarged, flattened; internodes short; tendrils intermittent, bifid to trifid. Leaves thick; upper surface light green, dull, smooth; lower surface pale green, pubescent, flocculent; lobes lacking; terminus acute; petiolar sinus deep, narrow; lateral sinus very shallow; teeth shallow, wide. Flowers on plan of six, nearly self-fertile, open late; stamens upright.

Fruit mid-season, keeps until mid-winter. Clusters medium to large, short, broad, tapering, loose; pedicel short; brush very short, pale green. Berries large, oval, dark purplish-red with thin bloom, very persistent; skin thick, tough, adherent, astringent; flesh pale green, translucent, tough, stringy, solid, foxy; good. Seeds adherent, two to five, large, long, brown.

Almeria

(Vinifera)

This is one of the varieties commonly found in eastern markets from Almeria and Malaga, Spain, although occasionally

it may come from California where the variety, or similar varieties confused with it, is now grown. This sort is remarkable for its wonderful keeping qualities; it is adapted only to hot interior regions. The Almeria cultivated by the California Experiment Station is described as follows:

"Vine vigorous; leaves of medium size, round and slightly or not at all lobed, quite glabrous on both sides, teeth obtuse and alternately large and small; bunches large, loose or compact, irregular conical; berries from small to large, cylindrical, flattened on the ends, very hard and tasteless."

America

(Lincecumii, Rupestris)

The notable qualities of America are vigor of growth and health of foliage in vine, and persistence of berries, which have strongly colored red juice, high sugar-content and excellent flavor. The grapes wholly lack the foxy taste and aroma of Labrusca and the variety, therefore, offers possibilities for breeding sorts lacking the foxy flavor of Concord and Niagara. America has great resistance to heat and cold. Also, it is said to be a suitable stock upon which to graft Vinifera varieties to resist phylloxera. The vigor of the vine and the luxuriance of the foliage make it an excellent sort for arbors. America was grown by T. V. Munson, Denison, Texas, from seed of Jaeger No. 43 pollinated by a male Rupestris. It was introduced about 1892.

Vine vigorous, hardy, productive. Canes long, numerous, dark reddish-brown with heavy bloom; nodes enlarged, flattened; tendrils intermittent, long, bifid. Leaves small, thin; upper surface glossy, smooth; lower surface light green, hairy; lobes lacking or faint, terminal one acute; petiolar sinus deep and wide; teeth of average depth and width. Flowers self-sterile, usually on plan of six, open late; stamens reflexed.

Fruit mid-season or later, keeps well. Clusters large, long, broad, tapering, irregular, single-shouldered, compact; pedicel short, slender with small warts; brush short, thick with red tinge. Berries small,

variable in size, round, purplish-black, glossy with purplish-red pigment, astringent; flesh dull white with faint red tinge, translucent, tender, melting, spicy, vinous, sweet; good. Seeds free, two to five, long, pointed, yellowish-brown.

Aminia

(Labrusca, Vinifera)

Aminia is one of the best early grapes, its season being with or a little after Moore Early. The grapes are of high quality and attractive appearance, but the bunches are small, variable in size, not well formed and the berries ripen unevenly. The vine is vigorous but is neither as hardy nor as productive as a commercial variety should be. In 1867 Isadora Bush, a Missourian, planted vines of Rogers No. 39 from several different sources. When these came into bearing, he distinguished three varieties. Bush selected the best of the three and, with the consent of Rogers, named it Aminia. In spite of Bush's care, there are two distinct grapes cultivated under this name.

Vine vigorous, precariously hardy, lacking in productiveness. Canes rough, long, thick, dark brown; nodes enlarged; internodes long; tendrils intermittent, long, trifid or bifid, persistent. Leaves large; upper surface dull, smooth; lower surface light green, pubescent; lobes three; terminal lobe acute; petiolar sinus deep, narrow, often closed and overlapping; basal sinus usually lacking; lateral sinus shallow, narrow; teeth shallow, wide. Flowers open in mid-season, self-sterile; stamens reflexed.

Fruit early, keeps well. Clusters small, broad, irregular, conical, sometimes with a long shoulder, loose; pedicel long with few warts; brush short, thick, brownish-red. Berries variable, round, dull black with thin bloom, persistent, firm; skin thick, tender, adherent with purplish-red pigment, astringent; flesh greenish, translucent, tender, solid, coarse, foxy; good. Seeds adherent, one to six, very large.

August Giant

(Labrusca, Vinifera)

August Giant is a hybrid between Labrusca and Vinifera in which the fruit characters are those of the latter species. In

appearance and taste of berry, the variety resembles Black Hamburg. The vine is usually vigorous and, considering its parentage, is very hardy. The foliage is thick and luxuriant but subject to mildew. Vigor of vine, beauty of foliage and the quality of the fruit make the variety desirable for the amateur. It needs a long-maturing season. August Giant was grown by N. B. White, Norwood, Massachusetts, in 1861, from seed of an early, large-berried, red Labrusca pollinated by Black Hamburg.

Vine very vigorous, hardy, subject to mildew. Canes long, numerous, thick, dark brown; nodes enlarged, flattened; internodes short; tendrils continuous, long, bifid or trifid. Leaves large, thick; upper surface dark green, glossy, smooth; lower surface pale green or bronzed, pubescent; lobes three, terminal one acute; petiolar sinus deep, narrow, frequently closed and overlapping; lateral sinus shallow or a notch; teeth shallow, narrow. Flowers open in mid-season, self-sterile; stamens reflexed.

Fruit mid-season, keeps well. Clusters of average size, short, broad, irregularly tapering, single-shouldered, loose; pedicel long, thick with large warts; brush short, thick, green or with brown tinge. Berries large, oval, purplish-red or black, dull with thick bloom, firm; skin tough, adherent, astringent; flesh green, translucent, tough, stringy; good. Seeds adherent, one to four, large, blunt, light brown.

Bacchus

(Vulpina, Labrusca)

Bacchus is an offspring of Clinton which it resembles in vine and leaf characters, but surpasses in quality of fruit and in productiveness of vine. The special points of merit of the variety are: resistance to cold, resistance to phylloxera, freedom from fungi and insects, productiveness, ease of multiplication and capacity to bear grafts. Its limitations are: poor quality for table use, inability to withstand dry soils or droughts, and nonadaptability to soils containing much lime. The variety originated with J. H. Ricketts, Newburgh, New York, and was first exhibited by him in 1879.

Vine very vigorous, hardy, healthy, productive. Canes numerous, dark brown with bloom at the nodes which are enlarged and flattened; tendrils bifid. Leaves small; upper surface dark green, glossy, smooth; lower surface dull green, smooth; lobes three, terminal one acuminate; petiolar sinus shallow, narrow, sometimes overlapping; basal sinus lacking; lateral sinus shallow, wide. Flowers open early, self-sterile; stamens upright.

Fruit late, keeps well, hangs long. Clusters small, slender, uniform, cylindrical, single-shouldered, compact; pedicel short, slender with a few small warts; brush short, wine-colored. Berries small, round, black, glossy, covered with thin bloom, hang well to pedicels, firm; skin thin, adherent, contains much wine-colored pigment, slightly astringent; flesh dark green, translucent, fine-grained, tough, vinous, spicy; fair quality. Seeds clinging, one to four, many abortive, large, short and wide, plump, sharply pointed, brown.

Bakator

(Vinifera)

This is a Hungarian wine grape but its high quality and early season make it a desirable table-grape in the East. It seems to be grown but little on the Pacific slope. The following description is made from fruit grown at Geneva, New York:

Vine medium in vigor, productive. Young leaves tinged red at edges, upper surface glossy; mature leaves large, round, upper surface dull, lower surface downy; lobes five, terminal lobe acuminate; basal sinus deep, medium to narrow, closed to overlapping; lower lateral sinus deep, variable in width; upper lateral sinus deep, usually narrows; margins dentate, teeth shallow to medium deep. Flowers appear late; stamens reflexed.

Fruit ripens at Geneva the first or second week in October and keeps well in storage; clusters above medium in size, medium in length, broad, frequently double-shouldered, tapering, medium to loose; berries medium to small, oval, light red becoming dark when fully ripe, with thick bloom; skin thin, tender, adherent to the pulp; flesh greenish, juicy, tender, melting, vinous, sweet; quality very good.

Barry

(Labrusca, Vinifera)

Barry (Plate VII) is one of the best American black grapes, resembling in berry and in flavor and keeping quality of fruit its

European parent, Black Hamburg. The appearance of berry and bunch is attractive. The vine is vigorous, hardy and productive but susceptible to mildew. The ripening season is just after that of Concord. For the table, for winter keeping and for the amateur, this variety may be highly recommended. Barry was dedicated in 1869, by E. S. Rogers, who originated it, to Patrick Barry, distinguished nurseryman and pomologist. The variety is grown in gardens throughout the grape regions of eastern America.

Vine vigorous, hardy, productive, susceptible to mildew. Canes long, numerous, thick, dark brown with heavy bloom; nodes flattened; shoots glabrous; tendrils intermittent, bifid or trifid. Leaves large; upper surface light green, glossy, smooth; lower surface pale green, pubescent; lobes one to three, terminus acute; petiolar sinus deep, narrow, sometimes closed and overlapping; basal sinus usually lacking; lateral sinus shallow, narrow; teeth shallow. Flowers open in mid-season, self-sterile; stamens reflexed.

Fruit mid-season, keeps well. Clusters short, very broad, tapering, often subdividing into several parts, compact; pedicel with small warts. Berries large, oval, dark purplish-black, glossy, covered with heavy bloom, adherent; skin thin, tough, adherent; flesh pale green, translucent, tender, stringy, vinous, pleasant-flavored; good. Seeds adherent, one to five, large, deeply notched, with enlarged neck, brown.

Beacon

(Lincecumii, Labrusca)

Another of T. V. Munson's hybrids is Beacon. It is not well adapted to northern regions but does very well in the South. The vine is vigorous and bears a handsome, compact mass of foliage which retains its color and freshness through drouths and heat. Munson grew Beacon in 1887 from seed of Big Berry (a variety of Lincecumii) pollinated by Concord, the vine bearing first in 1889.

Vine vigorous, precariously hardy, productive. Canes short, slender, light brown. Leaves healthy, thick, dark green, sometimes rugose; veins showing indistinctly through the slight pubescence of

the lower surface. Flowers open in mid-season, on plan of five or six, self-fertile.

Fruit mid-season, keeps well. Clusters large, long, slender, cylindrical, usually high-shouldered, compact. Berries variable in size, round, purplish-black, dull with heavy bloom, firm; skin tough, adherent with a large amount of purplish-red pigment, astringent; flesh tender, aromatic, spicy, vinous, mildly subacid; good. Seeds free, large, broad, blunt, notched.

Berckmans

(Vulpina, Labrusca, Bourquiniana)

In Berckmans we have the fruit of Delaware on the vine of Clinton. The berry and bunch resemble Delaware in shape; the fruit is of the same color; bunch and berry are larger; the grapes keep longer; the flesh is firmer but the quality is not so good, the flesh lacking tenderness and richness in comparison with Delaware. The vine of Berckmans is not only more vigorous, but is less subject to mildew than that of Delaware. The vine characters are not, however, as good as those of Clinton. The variety is poorly adapted to some soils, and on these the grapes do not color well. In spite of many good qualities, Berckmans is but an amateur's grape. The name commemorates the viticultural labors of P. J. Berckmans, a contemporary and friend of A. P. Wylie, of Chester, South Carolina, who originated the variety. Berckmans came from Delaware seed fertilized by Clinton, the seed having been sown in 1868.

Vine vigorous, hardy, productive. Canes long, numerous, slender, dark brown; nodes prominent, flattened; internodes short; shoots glabrous; tendrils intermittent, long, bifid. Leaves small, thin; upper surface light green, smooth; lower surface pale green, glabrous; lobes one to three, terminal one acute; petiolar sinus shallow, wide; basal sinus usually lacking; lateral sinus shallow. Flowers open early, self-fertile; stamens upright.

Fruit ripens with Delaware. Clusters shouldered, compact, slender; pedicel long, slender with few warts; brush short, light green. Berries small, oval, Delaware-red, darker when well ripened, covered

with thin bloom, persistent; skin thin, tough, adherent, astringent; flesh pale yellowish-green, translucent, fine-grained, tender, melting, vinous, sweet, sprightly; very good. Seeds free, one to four, small, broad, blunt, brown.

Black Eagle

(Labrusca, Vinifera)

The fruit of Black Eagle is of the best, but the vine lacks in vigor, hardiness and productiveness and is self-sterile. Bunch and berry are large and attractive. The season is about with Concord. Black Eagle has wholly failed as a commercial variety, and its several weaknesses prevent amateurs from growing it widely. The variety originated with Stephen W. Underhill, Croton-on-Hudson, New York, from seed of Concord pollinated by Black Prince. It fruited first in 1866.

Vine vigorous, precariously hardy, unproductive. Canes rough, thick, reddish-brown with light bloom; nodes enlarged, flattened internodes long; tendrils continuous, long, bifid or trifid. Leaves thick; upper surface dark green, glossy, smooth to rugose; lobes five; terminal lobe acute; petiolar sinus deep; lateral sinus wide, narrowing towards top, deep. Flowers open in mid-season, self-sterile; stamens reflexed.

Fruit mid-season, keeps well. Clusters large, long, tapering, single- or double-shouldered, compact; pedicel long, slender with few warts; brush short, pale green. Berries variable in size, oval, black, glossy with thick bloom; skin tender, thin, adherent with wine-colored pigment; flesh pale green, translucent, tender, vinous; good. Seeds free, one to four, large.

Black Hamburg

(Vinifera)

Black Hamburg (Plate VI) is an old European sort, long the mainstay in forcing-houses in Belgium, England and America and now popular out of doors in California. It is an excellent table-grape but, while it keeps well, its tender skin does not permit its being shipped far, especially when grown out of doors.

The vine is subject to disease. The following description of the fruit is made from grapes grown in the greenhouse:

Bunches very large, often a foot in length and weighing several pounds; very broad at the shoulder and gradually tapering to a point; compact, oftentimes too compact; berries very large, round or slightly round-oval; skin rather thick; dark purple becoming black at full maturity; flesh firm, juicy, sweet and rich; quality very good or best. Season early in the forcing-house but rather late out of doors.

Black Malvoise

(Vinifera)

This variety is rather widely grown in California as an early table-grape and might be worth trying in eastern grape regions. While the fruit is not of the best quality, it is good. The following description is compiled:

Vine vigorous, healthy and productive; wood long-jointed, rather slender, light brown. Leaves of medium size, oval, evenly and deeply five-lobed; basal sinus open, with nearly parallel sides; upper surface smooth, almost glabrous; lower surface slightly tomentose on the veins and veinlets. Bunches large, loose, branching; berries large, oblong, reddish black with faint bloom; flesh firm, juicy, crisp; flavor lacking in richness and character; quality not high. Season early, keeping and shipping but poorly.

Black Morocco

(Vinifera)

Black Morocco very generally meets the approval of grape-growers on the Pacific slope without being a prime favorite for either home use or commerce. The grapes are not high enough in quality for a home vineyard, and, while they ship well, are hard to handle because of the large size and rigidity of the bunches. Another fault is that the vines are subject to root-knot. The chief asset of the variety is handsome appearance of fruit. This variety is remarkable for the num-

ber of second-crop bunches which it produces on the laterals. The following description is compiled:

Vine very vigorous, productive; canes spreading, few. Leaves medium to small, very deeply five-lobed; the younger leaves truncate at base, giving them a semi-circular outline, with long, sharp teeth alternating with very small ones; glabrous, or nearly so, on both sides. Bunches very large, short, shouldered, compact and rigid; berries very large, round, often misshapen from compression; dull purple, lacking color in the center of the bunch; flesh firm, crisp, neutral in flavor, lacking in richness; quality rather low. Season late, keeping and shipping well.

Brighton

(Labrusca, Vinifera)

Brighton (Plate VIII) is one of the few Labrusca-Vinifera hybrids which have attained prominence in commercial vineyards. It ranks as one of the leading amateur grapes in eastern America and is among the ten or twelve chief commercial sorts of this region. Its good points are: for the fruit, high quality; for the vine, vigorous growth, productiveness, adaptability to various soils and ability to withstand fungi. Brighton has two serious defects which keep it from taking higher rank as a commercial variety: it deteriorates in quality very quickly after maturity, so that it cannot be kept for more than a few days at its best, hence cannot well be shipped to distant markets; and it is self-sterile to a more marked degree than any other commonly-grown grape. Brighton is a seedling of Diana Hamburg pollinated by Concord, raised by Jacob Moore, Brighton, New York. The original vine fruited first in 1870.

Vine vigorous, hardy, productive, subject to mildew. Canes long, numerous, light brown; nodes enlarged, usually flattened; internodes long; tendrils continuous, long, bifid. Leaves large, thick; upper surface dark green, dull, smooth; lower surface pale green, pubescent; lobes three when present, terminal one acute; petiolar sinus inter-

PLATE XXIV. — Moore Early ($\times \frac{3}{5}$).

mediate in depth and width; lateral sinus shallow; teeth narrow. Flowers open late, self-sterile; stamens reflexed.

Fruit mid-season. Clusters large, long, broad, tapering, heavily shouldered, loose; pedicel thick; brush pale green with brown tinge, thick, short. Berries irregular, large, oval, light red, glossy with heavy bloom, persistent, soft; skin thick, tender, adherent, astringent; flesh green, transparent, tender, stringy, melting, aromatic, vinous, sweet; very good. Seeds free, one to five, broad, light brown.

Brilliant

(Labrusca, Vinifera, Bourquiniana)

Brilliant is a cross between Lindley and Delaware. In cluster and size of berry it resembles Lindley; in color and quality of fruit it is about the same as Delaware, differing chiefly in having more astringency in the skin. Its season is about with Delaware. The grapes do not crack or shell, therefore ship well, and have very good keeping qualities, especially on the vine where they often hang for weeks. The vine is vigorous and hardy. The defects which have kept Brilliant from becoming one of the standard commercial sorts are: marked susceptibility to fungi, variability in size of cluster, unevenness in ripening and unproductiveness. In favorable situations this variety pleases the amateur, and the commercial grower often finds it profitable. The seed which produced Brilliant was planted by T. V. Munson, Denison, Texas, in 1883 and the variety was introduced in 1887.

Vine vigorous, hardy, rather unproductive. Canes long, numerous, thick, dark brown; nodes enlarged, flattened; internodes long; tendrils intermittent, long, bifid. Leaves large, thick; upper surface dark green, dull, rugose; lower surface gray-green, downy; obscurely three-lobed with terminal lobe acute; petiolar sinus deep, narrow; basal and lateral sinuses obscure and shallow when present; teeth intermediate in depth and width. Flowers open late, self-fertile; stamens upright.

Fruit early mid-season, keeps well. Clusters medium, blunt, cylindrical, usually shouldered, compact; pedicel short, thick with a few small warts; brush short, thick, pale green with reddish tinge.

Berries round, dark red, glossy with thin bloom, strongly adherent, firm; skin thin, tough, adherent; flesh pale green, transparent, juicy, stringy, fine-grained, vinous, sweet; good. Seeds clinging, one to four, large, broad, elongated, plump, light brown.

Brown

(Labrusca)

In spite of many encomiums in the past quarter century, Brown has not received favorable recognition from fruit-growers. The quality is not high, the berries shatter badly, and the vine is lacking in vigor. Brown is a seedling of Isabella which came up in a yard at Newburgh, New York, about 1884.

Vine hardy, productive. Canes short, slender, dark brown; tendrils continuous. Leaves healthy, light green, glossy; veins well defined, distinctly showing through the thick bronze of the lower surface. Flowers open early, self-fertile stamens upright.

Fruit large, keeps well. Clusters small to medium, slender, cylindrical or tapering, usually single-shouldered. Berries intermediate in size, oval, black with thick bloom, drop soon after ripening; skin adherent; flesh juicy, tough, fine-grained, a little foxy, mild next the skin but tart at center; good. Seeds short, blunt, light brown.

Campbell Early

(Labrusca, Vinifera)

The meritorious qualities of Campbell Early (Plate IX) are: The grapes are high in quality when mature; free from foxiness and from acidity about the seeds; have small seeds which easily part from the flesh; are early, ripening nearly a fortnight before Concord; bunch and berry are large and handsome; and the vines are exceptionally hardy. Campbell Early falls short in not being adapted to many soils; the variety lacks productiveness; the grapes attain full color before they are ripe and are, therefore, often marketed in an unripe condition; the bunch is variable in size; and the color of the berry is not attractive. George W. Campbell, Delaware, Ohio, grew this

variety from a seedling of Moore Early pollinated by a Labrusca-Vinifera hybrid. It bore first in 1892.

Vine vigorous, hardy, productive. Canes thick, dark reddish-brown, surface roughened with small warts; nodes flattened; internodes short; shoots pubescent; tendrils intermittent, short, bifid or trifid. Leaves large, thick; upper surface green, glossy; lower surface bronze, heavily pubescent; lobes three, usually entire, terminal one acute; petiolar sinus shallow, wide; basal sinus pubescent; lateral sinus wide or a notch; teeth shallow, narrow. Flowers self-fertile, open in mid-season; stamens upright.

Fruit early, keeps and ships well. Clusters usually large, long, broad, tapering, single-shouldered; pedicel short, slender with small warts; brush long, light wine color. Berries usually large, round, oval, dark purplish-black, dull with heavy bloom, persistent, firm; skin tough, thin, adherent with dark red pigment, astringent; flesh green, translucent, juicy, coarse, vinous, sweet from skin to center; good. Seeds free, one to four, light brown, often with yellow tips.

Canada

(Vulpina, Labrusca, Vinifera)

Canada is considered the most desirable hybrid between Vulpina and Vinifera. The variety shows Vinifera more than Vulpina parentage; thus, in susceptibility to fungal diseases, in shape, color and texture of foliage, in the flavor of the fruit and in the seeds, there are marked indications of Vinifera; while the vine, especially in the slenderness of its shoots and in the bunch and berry, shows Vulpina. Canada has little value as a dessert fruit but makes a very good red wine or grape-juice. Canada is a seedling of Clinton, a Labrusca-Vulpina hybrid, fertilized by Black St. Peters, a variety of Vinifera. Charles Arnold, Paris, Ontario, planted the seed which produced Canada in 1860.

Vine very vigorous, hardy, productive. Canes long, numerous, slender, ash-gray, reddish-brown at nodes with heavy bloom; nodes enlarged; internodes short; tendrils intermittent, short, trifid or bifid. Leaves thin; upper surface light green, smooth; lower surface pale green, hairy; terminal lobe acute; petiolar sinus deep, narrow;

basal sinus variable in depth and width; lateral sinus deep and narrow; teeth deep and wide. Flowers self-sterile, early; stamens upright.

Fruit mid-season, keeps well. Clusters long, slender, uniform, cylindrical, compact; pedicel long, slender, smooth; brush short, light brown. Berries small, round, purplish-black, glossy with heavy bloom, persistent, firm; skin thin, tough, adherent; flesh dark green, very juicy, fine-grained, tender, spicy, pleasant vinous flavor, agreeably tart; good. Seeds free, one to three, blunt, light brown.

Canandaigua

(Labrusca, Vinifera)

Canandaigua is worth attention because of the exceptionally good keeping qualities of the grapes. The flavor is very good at picking time but seems, if anything, to improve in storage. The vine characters are those of Labrusca-Vinifera hybrids, and in these the variety is the equal of the average cultivated hybrid of these two species. The characters of the fruit, also, show plainly an admixture of Vinifera and Labrusca so combined as to make the grapes very similar to the best of such hybrids. Canandaigua is a chance seedling found by E. L. Van Wormer, Canandaigua, New York, growing among wild grapes. It was distributed about 1897.

Vine vigorous, doubtfully hardy, productive. Canes long, few, reddish-brown, faint bloom; nodes enlarged, flattened; tendrils semi-continuous, bifid, dehisce early. Leaves large, thin; upper surface light green; lower surface gray-green. Flowers sterile or sometimes partly self-fertile, open in mid-season; stamens reflexed.

Fruit late mid-season, keeps unusually well. Clusters variable in size, usually heavily single-shouldered, loose to medium. Berries large, oval, black, covered with thick bloom, persistent; skin adherent, thin, tough; flesh firm, sweet and rich; good, improves as season advances. Seeds long with enlarged neck.

Carman

(Lincecumii, Vinifera, Labrusca)

Carman is a grape having the characters of three species and hence is of interest to grape improvers. It has not become

popular with growers, chiefly because the grapes ripen very late and are not of high quality. The most valuable character of the variety is that of long keeping, whether hanging on the vine or after harvesting. T. V. Munson, Denison, Texas, raised Carman from seed of a wild post-oak grape taken from the woods, pollinated with mixed pollen of Triumph and Herbemont. It was introduced in 1892.

Vine very vigorous, hardy, rather productive. Canes long, numerous, thick, reddish-brown; nodes enlarged, flattened; internodes long; tendrils intermittent, long, trifid. Leaves large, thick; upper surface light green, glossy, older leaves rugose; lower surface pale green, pubescent; terminal lobe acute; petiolar sinus deep; basal sinus absent or shallow; lateral sinus shallow when present. Flowers self-fertile or nearly so, open very late; stamens upright.

Fruit late, keeps well. Clusters variable in size, tapering, single-shouldered, compact; pedicel short, slender, smooth; brush short, slender, wine-colored. Berries small, round, slightly oblate, purplish-black, glossy, covered with heavy bloom, persistent, firm; skin thin, tough, free; flesh yellowish-green, tender, post-oak flavor, vinous, spicy; good to very good. Seeds free, one to four, small, blunt, brown.

Catawba

(Labrusca, Vinifera)

Arkansas, Catawba Tokay, Cherokee, Fancher, Keller's White, Lebanon, Lincoln, Mammoth Catawba, Mead's Seedling, Merceron, Michigan, Muncy, Omega, Rose of Tennessee, Saratoga, Singleton, Tekomah, Tokay, Virginia Amber.

Catawba has long been the standard red grape in the markets of eastern America, chiefly because the fruit keeps well and is of high quality. The vine is vigorous, hardy and productive, but the foliage and fruit are susceptible to fungi. These two faults account for the decline of Catawba in grape regions in the United States and for its growing unpopularity. In botanical characters and in adaptations and susceptibilities, the variety suggests Vinifera crossed with Labrusca. The characters of

Catawba seem readily transmissible to its offspring and, besides having a number of pure-bred descendants which more or less resemble it, it is a parent of a still greater number of cross-breeds. As with Catawba, most of its progeny show Vinifera characters, as intermittent tendrils, Vinifera color of foliage, a vinous flavor wholly or nearly free from foxiness, and the susceptibilities of Labrusca-Vinifera hybrids to certain diseases and insects. Catawba was introduced by John Adlum, District of Columbia, about 1823. Adlum secured cuttings from a Mrs. Scholl, Clarksburgh, Montgomery County, Maryland, in the spring of 1819. Its further history is not known.

Vine vigorous, hardy, productive. Canes numerous, thick, dark brown; nodes enlarged; tendrils continuous, bifid or trifid. Leaves large; upper surface light green, dull, smooth; lower surface grayish-white, heavily pubescent; lobes sometimes three, terminal one acute; petiolar sinus deep, narrow; basal sinus often lacking; lateral sinus narrow; teeth shallow, narrow. Flowers self-fertile, open late, stamens upright.

Fruit late, keeps well. Clusters large, long, broad, tapering, single- or sometimes double-shouldered, loose; pedicel with a few inconspicuous warts; brush short, pale green. Berries of medium size, oval, dull purplish-red with thick bloom, firm; skin thick, adherent, astringent; flesh green, translucent, juicy, fine-grained, vinous, sprightly, sweet and rich; very good. Seeds free, frequently abortive, two, broad-necked, distinctly notched, blunt, brown.

Champion

(Labrusca)

Beaconsfield, Early Champion, Talman's Seedling

Champion is a favorite early grape with some growers, although the poor quality of the fruit should have driven it from cultivation long ago. The characters which have kept it in the market are earliness, good shipping qualities, attractive appearance of fruit, and a vigorous, productive, hardy vine. The hardiness of the vine and the short season of fruit develop-

ment make it a good variety for northern climates. This grape is best in appearance of fruit, in quality and in the quantity produced, on light sandy soils. The origin of Champion is unknown. It was first grown about 1870 in New York.

Vine very vigorous, hardy and productive. Canes of average size, dark brown; nodes enlarged, flattened; internodes short; shoots pubescent; tendrils continuous, long, bifid. Leaves large; upper surface dark green, dull, rugose; lower surface dull gray, downy; lobes usually three, often obscurely five, terminal one acute; petiolar sinus deep; teeth shallow. Flowers self-fertile, early; stamens upright.

Fruit early, three weeks before Concord, season short. Clusters medium in size, blunt, cylindrical, usually not shouldered, compact; pedicel short with inconspicuous warts; brush white tinged with bronze. Berries medium in size, round, dull black covered with heavy bloom, soft; skin thick, tender, adherent, astringent; flesh light green, translucent, juicy, fine-grained, tender, foxy; poor in quality. Seeds adherent, one to five, broad, long, blunt, light brown.

Chasselas Golden

(Vinifera)

Chasselas Dore, Fontainebleau, Sweetwater

Several qualities have made Chasselas Golden a favorite grape wherever it can be grown. The variety is adapted to widely differing environments; the season of ripening is early; while not choicely high, the quality of the grapes is good and they are beautiful, clear green tinged with beautiful golden bronze where exposed to the sun. Chasselas Golden is a popular variety on the Pacific slope and should be one of the first Viniferas to be tried in the East. The following description was made from fruit grown at Geneva, New York:

Vine medium in vigor, very productive; buds open in mid-season. Young leaves tinged with red on both upper and lower surfaces, thinly pubescent to glabrous; mature leaves medium to above in size, slightly cordate; upper surface glabrous, lower surface slightly pubescent along the veins; lobes five in number, terminal lobe acuminate;

basal sinus broad and rather deep; lower lateral sinus variable, usually broad and sometimes deep; upper lateral sinus broad and frequently deep; teeth large, obtuse to rounded. Flowers late; stamens upright.

Fruit ripens early and keeps well in storage; clusters large, long, broad, tapering, sometimes with a single shoulder, compactness medium; berries medium to above, slightly oval, pale green to clear yellow, with thin bloom; skin thin, tough, adherent, slightly astringent; flesh greenish, translucent, firm, juicy, tender, sweet; good.

Chasselas Rose

(Vinifera)

Chasselas Rose is very similar to Chasselas Golden, differing chiefly in smaller bunch and berry and slightly different flavor which is possibly better. It is a standard sort in California and should be planted in the East where the culture of Viniferas is attempted. The description is made from fruit grown at Geneva, New York:

Vine of medium vigor, productive. Opening leaves tinged with red on both surfaces, mature leaves small, round; upper surface medium green, somewhat dull, smooth; lower surface glabrous; lobes three; basal sinus medium in depth and of variable width; lateral sinus deep, narrow; teeth shallow, wide, dentate. Flowers appear late; stamens upright.

Fruit ripens the second week in October and is a good keeper though it loses its flavor in storage; clusters above and below medium, long, tapering to cylindrical, compact; berries medium in size, roundish-oval, light red changed to violet-red by the bloom; skin thin, astringent, juicy, tender, sweet, mild; quality good.

Chautauqua

(Labrusca)

In appearance of fruit, Chautauqua is very similar to Concord, its parent, but the grapes ripen a few days earlier and are of better quality, although they do not differ in these respects sufficiently to make the variety much more than an easily recognized strain of Concord. Chautauqua is a volunteer

seedling of Concord, found near Brocton, New York, by H. T. Bashtite about 1890.

Vine vigorous, doubtfully hardy, unproductive. Canes long, thick, cylindrical; internodes long; tendrils continuous, trifid. Leaves large, irregularly round, dark green; upper surface dark green; lower surface tinged with bronze; leaf entire or faintly three-lobed. Flowers semi-fertile, open in mid-season or earlier; stamens upright.

Fruit early in mid-season. Clusters medium to large, broad, sometimes single-shouldered, compact. Berries large, round or slightly oval, purplish-black with abundant bloom, shatter badly; skin thin, very astringent; flesh tough, vinous, sweet at skin, acid at center; good to very good. Seeds few, free, broad, plump.

Clevener

(Vulpina, Labrusca)

This variety has long been grown in New Jersey and New York, and in both states is highly esteemed as a wine-grape. The fruit is remarkable in coloring very early and in ripening late. The vine is hardy, very vigorous, succeeds in various soils, and since it bears grafts well is an excellent sort upon which to graft varieties not thriving on their own roots. Clevener is self-sterile and must be planted with some other variety to set fruit well. In spite of its good qualities, Clevener is hardly holding its own in commercial vineyards, and it is not a desirable fruit for the amateur who wants a table-grape. Clevener has been raised in the vicinity of Egg Harbor, New Jersey, since about 1870, but its place and time of origin are unknown.

Vine a rampant grower, hardy, productive. Canes long, numerous, thick, dark reddish-brown with heavy bloom; nodes enlarged; tendrils continuous, bifid. Leaves unusually large, dark green with well-defined ribs showing through the thin pubescence of the under surface; lobes wanting or faint; teeth deep, wide. Flowers self-sterile, open very early; stamens reflexed.

Fruit late, keeps well. Clusters do not always fill well, small, short, slender, irregularly tapering, often with a single shoulder. Berries small, round or slightly flattened, black, glossy, covered with

heavy bloom, persistent, firm; skin tough, thin, inclined to crack, adherent with much purplish-red pigment; flesh reddish-green, juicy, tender, soft, fine-grained, aromatic, spicy; good. Seeds free, notched, sharp-pointed, dark brown.

Clinton

(Vulpina, Labrusca)

Worthington

Clinton (Plate X) came into prominence because of vigor, hardiness, fruitfulness and immunity to phylloxera. A serious defect is that the vines bloom so early that the blossoms are often caught by late frosts in northern climates. Other defects are: the fruit is small and sour, and the seeds and skins prominent. The fruit colors early in the season but does not ripen until late, a slight touch of frost improving the flavor. Clinton bears grafts well, making a quick and firm union with Labrusca and Vinifera, and the vines are easily propagated from cuttings. This variety has been used widely in grape-breeding, and its blood can be traced in many valuable varieties. The offspring of Clinton are usually very hardy, and this, taken with its other desirable characters, makes it an exceptionally good starting-point for breeding grapes for northern latitudes. Clinton is an old sort, the Worthington, known as early as 1815, renamed; it began to attract attention about 1840.

Vine vigorous, hardy, healthy, productive. Canes long, numerous, slender, reddish-brown; nodes enlarged, flattened; shoots smooth; tendrils intermittent, sometimes continuous, bifid. Leaves hang until late in the season, small, thin; upper surface dark green, smooth; lower surface pale green, glabrous; petiolar sinus deep, narrow, urn-shaped; basal and lateral sinuses shallow; teeth wide. Flowers self-fertile, open early; stamens upright.

Fruit mid-season. Clusters small, slender, cylindrical, uniform, single-shouldered, compact; pedicel short, very slender, smooth; brush tinged with red. Berries small, round, oval, purplish-black, glossy, covered with thick bloom, adherent, firm; skin very thin,

PLATE XXV. — Muscat Hamburg ($\times \frac{2}{3}$).

tough, free from pulp with much wine-colored pigment, astringent; flesh dark green, juicy, fine-grained, tough, solid, spicy, sour, vinous. Seeds adherent, two, short, blunt, brownish.

Colerain

(Labrusca)

This is one of the numerous white seedlings of Concord and one of the few with sufficient merit to be kept in cultivation. The vine has the characteristic foliage and habit of growth of its parent, but the fruit is earlier by a week, is of much higher quality and lacks the foxiness of most Labruscas. The grapes are sprightly and vinous, and neither seeds nor skin are as objectionable as in the parent. The fruit hangs to the vine and keeps well, but owing to tender pulp does not ship well. The variety is unproductive in some localities. Colerain is worthy a place in home vineyards. David Bundy, Colerain, Ohio, grew this variety from seed of Concord planted in 1880.

Vine vigorous, hardy, healthy, unproductive. Canes slender, dark reddish-brown; nodes flattened; internodes short, bifid. Leaves thick; upper surface light green, dull, smooth; lower surface bronze, downy; leaf not lobed, terminus acute; petiolar sinus wide; basal and lateral sinus very shallow when present; teeth shallow. Flowers self-fertile, opening in mid-season; stamens upright.

Fruit early. Clusters medium in size and length, slender, blunt, tapering, irregular, strongly shouldered, compact; pedicel slender, smooth; brush green. Berries round, light green, glossy with thin bloom, persistent; skin unusually thin, tender, adherent, unpigmented, astringent; flesh pale green, translucent, juicy, fine-grained, tender, soft, vinous, sweet; good. Seeds free, one to three, small, broad, notched, short, plump, brown.

Columbian Imperial

(Labrusca, Vulpina)

Columbian, Jumbo

Columbian Imperial is a Labrusca-Vulpina hybrid chiefly remarkable for the great size of its reddish-black berries, al-

though the vine is so exceptionally healthy and vigorous as to give it prominence for these characters as well. The variety has remarkably thick leathery leaves which seem almost proof against either insects or fungi. The quality of the fruit, however, is inferior, and the small clusters vary in number of berries and these shell easily. The only value of the variety is for exhibition purposes and for breeding to secure the desirable characters named. The parentage of Columbian Imperial is unknown. It originated with J. S. McKinley, Orient, Ohio, in 1885.

Vine vigorous, hardy, healthy, unproductive. Canes long, numerous, thick, dark reddish-brown, heavily pubescent, spiny; nodes prominent; internodes short; tendrils continuous, long, bifid. Leaves green, very thick; lower surface pale green shading into bronze on older leaves with little pubescence; lobes three, indistinct; teeth sharp, shallow, wide. Flowers self-fertile; stamens upright.

Fruit late. Clusters medium in size, sometimes shouldered; peduncle slender; pedicel long; brush long, slender, green. Berries very large, round, slightly oval, dull reddish-black with faint bloom, firm; skin thick, tough, unpigmented; flesh juicy, tough, sweet at the skin but acid at center; fair in quality. Seeds adherent, large, plump, broad, blunt.

Concord

(Labrusca)

Concord (Plate XI) is the most widely known of the grapes of this continent, and with its offspring, pure-bred and cross-bred, furnishes 75 per cent of the grapes of eastern America. The preëminently meritorious character of Concord is that it adapts itself to varying conditions; thus, Concord is grown with profit in every grape-growing state in the Union and to an extent not possible with any other variety. A second character which commends Concord is fruitfulness — the vine bears large crops year in and year out. Added to these points of superiority, are: hardiness; ability to withstand the ravages of diseases and insects; comparative earliness; certainty of

maturity in northern regions; and fair size and handsome appearance of bunch and berry. Concord also blossoms late in the spring and does not suffer often from spring frosts, nor is the fruit often injured by late frosts. The crop hangs well on the vine.

The variety is not, however, without faults: the quality is not high, the grapes lacking richness, delicacy of flavor and aroma, and having a foxy taste disagreeable to many; the seeds and skin are objectionable, the seeds being large and abundant and difficult to separate from the flesh, and the skin being tough and unpleasantly astringent; the grapes do not keep nor ship well and rapidly lose flavor after ripening; the skin cracks and the berries shell from the stems after picking; and the vine is but slightly resistant to phylloxera. While Concord is grown in the South, it is essentially a northern grape, becoming susceptible to fungi in southern climates and suffering from phylloxera in dry, warm soils.

The botanical characters of Concord indicate that it is a pure-bred Labrusca. Seeds of a wild grape were planted in the fall of 1843 by E. W. Bull, Concord, Massachusetts, plants from which fruited in 1849. One of these seedlings was named Concord.

Vine vigorous, hardy, healthy, productive. Canes long, thick, dark reddish-brown; nodes enlarged, flattened; internodes long; shoots pubescent; tendrils continuous, long, bifid, sometimes trifid. Leaves large, thick; upper surface dark green, glossy, smooth; lower surface light bronze, heavily pubescent; lobes three when present, terminal one acute; petiolar sinus variable; basal sinus usually lacking; lateral sinus obscure and frequently notched; teeth shallow, narrow. Flowers self-fertile, open in mid-season; stamens upright.

Fruit mid-season, keeps from one to two months. Clusters uniform, large, wide, broadly tapering, usually single-shouldered, sometimes double-shouldered, compact; pedicel thick, smooth; brush pale green. Berries large, round, glossy, black with heavy bloom, firm; skin tough, adherent with a small amount of wine-colored pigment, astringent; flesh pale green, translucent, juicy, fine-grained, tough, solid, foxy; good. Seeds adherent, one to four, large, broad, distinctly notched, plump, blunt, brownish.

Cottage

(Labrusca)

In vine and fruit, Cottage resembles its parent, Concord, having, however, remarkably large, thick, leathery leaves. It is noted also for its strong, branching root system and canes so rough as to be almost spiny. The fruit is better in quality than that of its parent, having less foxiness and a richer, more delicate flavor. The crop ripens from one to two weeks earlier than Concord. The good qualities of the variety are offset by comparative unproductiveness and unevenness in ripening. Cottage is recommended as an early grape of the Concord type for the garden. This variety was grown from seed of Concord by E. W. Bull, Concord, Massachusetts. It was introduced in 1869.

Vine vigorous, healthy, hardy. Canes rough, hairy, long, numerous, dark brown; nodes enlarged; shoots very pubescent; tendrils continuous, bifid. Leaves large, thick; upper surface dark green, glossy, smooth or rugose; lower surface tinged with bronze, pubescent; leaf entire with terminal acute; petiolar sinus deep and wide; teeth shallow, wide. Flowers self-fertile, open early; stamens upright.

Fruit does not keep well. Clusters of medium size, broad, cylindrical, sometimes single-shouldered, compact; pedicel short, thick with a few small warts; brush dark red. Berries of medium size, round, dull black with heavy bloom, drop badly from pedicel, firm; skin thick, tender, adherent with dark purplish-red pigment, astringent; flesh juicy, tough, solid, foxy; good. Seeds free, one to four, large, broad, blunt, light brown.

Creveling

(Labrusca, Vinifera)

Bloom, Bloomburg, Catawissa, Columbia Bloom

Creveling was long a favorite black grape for the garden, where, if planted in good soil, it produces fine clusters of large, handsome, very good grapes. Under any but the best of care, however, the vine is unproductive and sets loose, straggling

bunches. The variety is markedly self-sterile. The origin of Creveling is uncertain. It was introduced about 1857 by F. F. Merceron, Catawissa, Pennsylvania.

Vine vigorous, not hardy, often unproductive. Canes long, numerous, thick, reddish-brown; nodes enlarged, flattened; internodes long; shoots glabrous; tendrils continuous, long, trifid or bifid. Leaves large, thick; upper surface dark green, dull, rugose; lower surface pale green, pubescent; lobes three, or obscurely five, terminal one acute; petiolar sinus deep, closed, overlapping; basal sinus very shallow; lateral sinus shallow, narrow; teeth shallow. Flowers on plan of six, self-sterile, open in mid-season; stamens reflexed.

Fruit early, does not keep well. Clusters long, broad, irregularly tapering, single-shouldered, the shoulder often connected to the cluster by a long stem, loose; brush thick, dark wine-color. Berries large, oval, dull black, covered with heavy bloom, persistent, firm; skin thick, tough, adherent with wine-colored pigment, astringent; flesh pale green, translucent, juicy, stringy, tender, coarse, foxy; good. Seeds free, one to five, broad, notched, blunt, light brown.

Croton

(Vinifera, Labrusca, Bourquiniana)

The fruit of Croton is a feast both to the eye and to the palate. Unfortunately the vine is difficult to grow, being adapted to but few soils and proving unfruitful, weak in growth, precariously tender and subject to mildew and rot in unfavorable situations. The grapes have a delicate, sweet Vinifera flavor with melting flesh which readily separates from the few seeds. The crop hangs on the vines until frost and keeps well into the winter. In spite of high quality of fruit, Croton has never become widely distributed, wholly failing as a commercial variety. It originated with S. W. Underhill, Croton Point, New York, from a seed of Delaware pollinated by a European grape. Fruits were first exhibited in 1868.

Vine vigorous, tender, productive. Canes long, numerous, thick, dark reddish-brown; nodes enlarged; internodes short; shoots glabrous; tendrils intermittent, long, bifid. Leaves of medium size, hang late; upper surface light green, dull, smooth; lower surface pale

green, pubescent; lobes five, terminal one blunt; basal sinus narrow; lateral sinus deep and narrow; petiolar sinus narrow, often closed and overlapping; teeth shallow, wide. Flowers self-fertile, open late; stamens upright.

Fruit mid-season, keeps well. Clusters uniform, very large, long, slender, irregularly tapering with heavy shoulder, very loose; pedicel long, thick with inconspicuous warts; brush green. Berries irregular in size, round-elongated, yellowish-green with thin bloom, persistent, soft; skin thin, tough, adherent, unpigmented; flesh green, transparent, very juicy, melting, vinous, pleasant, agreeably sweet; very good. Seeds free, one to three, elongated, notched, sharply pointed.

CUNNINGHAM

(Bourquiniana)

Long, Prince Edward

Cunningham is cultivated very little in America, but in France, at one time, was one of the best-known grapes, both as a direct producer and as a stock for European varieties. It was much sought for by the French as a stock for large Vinifera cions, the size of the vine giving an opportunity for making a good graft. In the South, where the variety originated, Cunningham is not largely grown, as there are several other varieties of its type superior in fruit and vine. The vine is a capricious grower and is particular as to soil and climate. The grapes make a deep yellow wine of a very good quality but have little value as table-grapes. Cunningham originated with Jacob Cunningham, Prince Edward County, Virginia, about 1812.

Vine vigorous, spreading, productive. Canes large, long with stiff reddish hairs at base; shoots showing considerable bloom; tendrils intermittent, usually trifid. Leaves large, thick, round, entire or lobed; smooth and dark green above, yellowish green below, pubescent; petiolar sinus narrow, frequently overlapping.

Clusters of medium size, long, sometimes shouldered, very compact; pedicel long, slender with small warts; brush short, light brown. Berries small, purplish-black with thin bloom; skin thin, tough with much underlying pigment; flesh tender, juicy, sprightly; quality poor or but fair. Seeds two to five, oval.

Cynthiana

(Æstivalis, Labrusca)

Arkansas, Red River

There is controversy as to whether this variety differs from Norton. The two ripen at separate times, and the fruits differ a little so that they must be considered as distinct. Cynthiana is particular as to soil and location, preferring sandy loams and does not thrive on clays or limestones. While very resistant to phylloxera, this variety is not much used as a resistant stock because it is not easily propagated. The vines are resistant to mildew, black-rot, and anthracnose and are strong, vigorous growers. The cycle of vegetation for Cynthiana is long, the buds bursting forth early and the fruit maturing very late. The variety has no value as a table-grape but in the South is one of the best grapes for red wine. No doubt it will prove one of the best southern sorts for grape-juice. Cynthiana was received about 1850 by Prince, of Flushing, Long Island, from Arkansas, where it was found growing in the woods.

Vine vigorous, hardy, healthy, productive. Canes medium in length, numerous, reddish-brown with thick bloom; nodes enlarged; internodes short; shoots glabrous; tendrils intermittent or continuous, bifid. Leaves thick, firm; upper surface dark green, dull, rugose; lower surface tinged with blue, faintly pubescent, cobwebby; lobes variable in number, terminal one acute; petiolar sinus deep, narrow, closed, sometimes overlapping; basal sinus shallow; lateral sinus shallow, narrow; teeth shallow; stamens upright.

Fruit very late, keeps well. Clusters medium to small, long, tapering, often single-shouldered, compact; pedicel short, slender, with numerous warts; brush short, thick, wine-colored. Berries small, round, black, covered with heavy bloom, persistent, firm; skin thin, tough, adherent with purple pigment, astringent; flesh dark green, translucent, juicy, tough, firm, spicy, tart; poor in quality. Seeds adherent, one to six, small, short, blunt, dark brown.

Delaware

(Labrusca, Bourquiniana, Vinifera)

French Grape, Gray Delaware, Ladies' Choice, Powell, Ruff

Delaware (Plate VII) is used wherever American grapes are grown as the standard to gauge the quality of other grapes. Added to high quality in fruit, the variety withstands climatic conditions to which all but the most hardy varieties succumb, is adapted to many soils and conditions, and bears under most situations an abundant crop. These qualities make it, next to Concord, the most popular grape for garden and vineyard now grown in the United States. Besides the qualities named, the grapes mature sufficiently early to make the crop certain, are attractive in appearance, keep and ship well and are more immune than other commercial varieties to black-rot. Faults of the variety are: small vine, slow growth, susceptibility to mildew, capriciousness in certain soils and small berries. The first two faults make it necessary to plant the vines more closely than those of other commercial varieties. Delaware succeeds best in deep, rich, well-drained, warm soils, but even on these it must have good cultivation, close pruning and the crop must be thinned.

Delaware is grown North and South, westward to the Rocky Mountains. It is now proving profitable in many southern locations as an early grape to ship to northern markets. It is an especially desirable grape to cultivate in small gardens because of its delicious, handsome fruit, its compact habit of growth and its ample and lustrous green, delicately formed leaves which make it one of the most ornamental of the grapes. Delaware can be traced to the garden of Paul H. Provost, Frenchtown, New Jersey, where it was growing early in the nineteenth century, and from whence it was taken to Delaware, Ohio, in 1849 and from there distributed to fruit-growers.

Vine weak, hardy, productive. Canes short, numerous, slender, dark brown; nodes enlarged; internodes short; tendrils intermittent, short, bifid. Leaves small; upper surface dark green, dull, smooth; lower surface pale green, pubescent; lobes three to five in number, terminal one acute; petiolar sinus narrow; basal sinus narrow and shallow when present; lateral sinus deep, narrow; teeth shallow. Flowers self-fertile, open late; stamens upright.

Fruit early, keeps well. Clusters small, slender, blunt, cylindrical, regular, shouldered, compact; pedicel short, slender, smooth; brush light brown. Berries uniform in size and shape, small, round, light red, covered with thin bloom, persistent, firm; skin thin, tough, adherent, unpigmented, astringent; flesh light green, translucent, juicy, tender, aromatic, vinous, refreshing, sweet; best in quality. Seeds free, one to four, broad, notched, short, blunt, light brown.

Diamond

(Labrusca, Vinifera)

Few other grapes surpass Diamond in quality and beauty of fruit. When to its desirable fruit characters are added hardiness, productiveness and vigor of vine, the variety is surpassed by no other green grape. Diamond is a diluted hybrid between Labrusca and Vinifera and the touch of the exotic grape is just sufficient to give the fruit the richness in flavor of the Old World grape and not overcome the refreshing sprightliness of the native fox-grapes. The Vinifera characters are wholly recessive in vine and foliage, the plant resembling closely its American parent, Concord. Diamond is well established North and South and can be grown in as great a range of latitude as Concord. Jacob Moore, Brighton, New York, grew Diamond about 1870 from Concord seed fertilized by Iona.

Vine vigorous, hardy, productive. Canes short, brown with a slight red tinge; nodes enlarged; internodes short; tendrils intermittent, bifid. Leaves thick; upper surface light green, dull, smooth; lower surface light bronze, downy; lobes three in number, indistinct; petiolar sinus very shallow; teeth shallow. Flowers self-fertile, open early; stamens upright.

Fruit early, keeps well. Clusters medium to short, broad, blunt, cylindrical, often single-shouldered, compact; pedicel short, thick with a few inconspicuous warts; brush slender, pale green. Berries large, ovate, green with a tinge of yellow, glossy, covered with thin bloom, persistent, firm; skin thin, tough, adherent, astringent; flesh pale green, transparent, juicy, tender, melting, fine-grained, aromatic, sprightly; very good. Seeds free, one to four, broad and long, sharp-pointed, yellowish-brown.

Diana

(Labrusca, Vinifera)

Diana (Plate XII) is a seedling of Catawba to which its fruit bears strong resemblance, differing chiefly in having lighter color, in being less pulpy and more juicy. The flavor resembles that of Catawba but has less of the wild taste. The chief point of superiority of Diana over Catawba is in earliness, the crop ripening ten days sooner, making possible its culture far to the north. The defects of Diana are: the vine is tender in cold winters; the grapes ripen unevenly; the berries and foliage are susceptible to fungi; and the vine is a shy bearer. Diana demands poor, dry, gravelly soil without much humus or nitrogen. On clays, loams or rich soils, the vines make a rank growth, and the fruits are few, late and of poor quality. The vine needs to be long pruned and to have all surplus bunches removed, leaving a small crop to mature. Diana is a satisfactory grape for the amateur, and where it does especially well proves profitable for the local market. Mrs. Diana Crehore, Milton, Massachusetts, grew Diana from seed of Catawba, planted about 1834.

Vine vigorous, doubtfully hardy, often unproductive. Canes pubescent, long, reddish-brown, covered with thin bloom; nodes enlarged, flattened; internodes long; tendrils intermittent, long, bifid. Leaves large, thick; upper surface light green, heavily pubescent; lobes three to five, terminal one acute; petiolar sinus deep, wide, often closed and overlapping; basal sinus shallow; lateral sinus narrow; teeth shallow. Flowers self-fertile, open in mid-season; stamens upright.

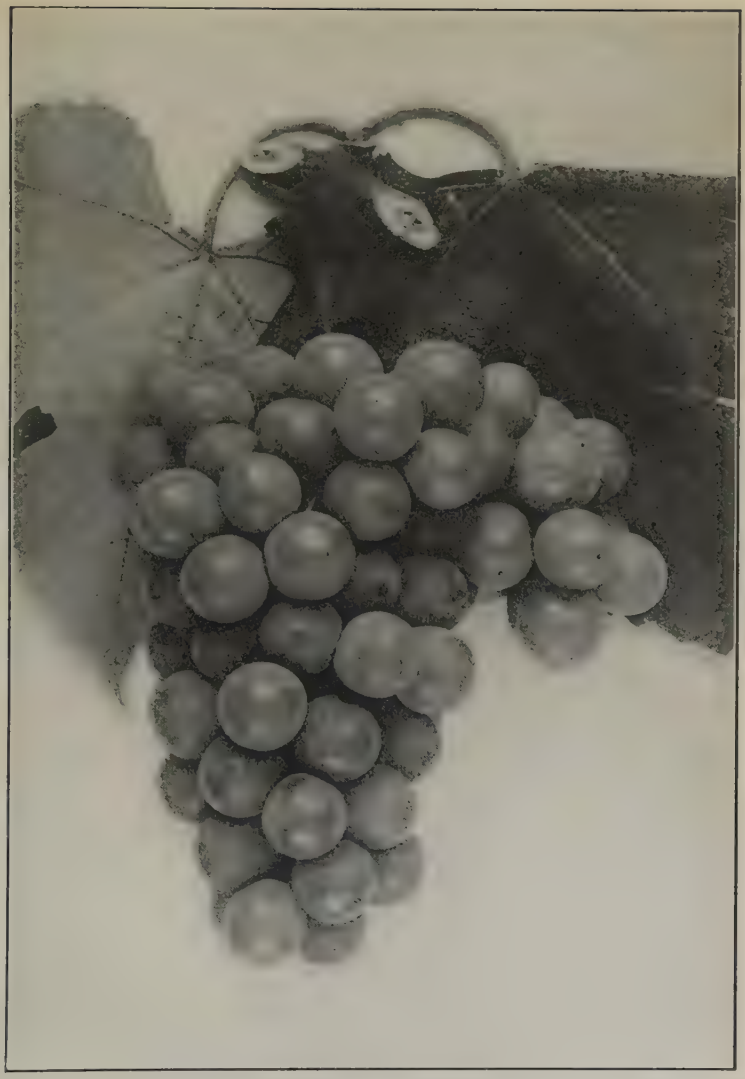

PLATE XXVI. — Niagara ($\times \frac{2}{3}$).

Fruit late, keeps well. Clusters large, broad, tapering, occasionally shouldered, compact; pedicel covered with small warts; brush slender, pale green. Berries medium in size, slightly ovate, light red covered with thin bloom, persistent, firm; skin thick, tough, slightly adherent; flesh pale green, translucent, juicy, tough, fine-grained, vinous, good. Seeds adherent, one to three, light brown.

Downing

(Vinifera, Æstivalis. Labrusca)

Downing is well worthy a place in the garden because of the high quality, handsome appearance and good keeping qualities of the grapes. Added to these qualities of the fruits are fair vigor and health of vine. When grown as far north as New York, the vine should be laid down in the winter or receive other protection. In most seasons, unremitting warfare must be kept up to check mildew. In appearance of bunch and berry, Downing is distinct, the clusters being large and well-formed and the berries having the oval shape of a Malaga. The flesh, also, shows *Vitis vinifera* in texture and quality, while neither seeds nor skins are as objectionable as in pure-bred American varieties. J. H. Ricketts, Newburgh, New York, first grew Downing about 1865.

Vine tender to cold, unproductive. Canes short, few, slender, dark green with an ash-gray tinge, surface covered with thin bloom, often roughened with a few small warts; nodes much enlarged, strongly flattened; internodes short; tendrils intermittent, bifid or trifid. Leaves small, round, thick; upper surface dark green, glossy, rugose; lower surface dark green, glabrous; lobes one to five, terminal lobe acute; petiolar sinus narrow, closed and overlapping; basal sinus shallow and narrow when present; lateral sinus shallow, narrow: teeth wide, deep. Flowers open late; stamens upright.

Fruit late, keeps until spring. Clusters large, long, slender, cylindrical, sometimes loosely shouldered; pedicel slender, covered with numerous warts; brush long, slender, green. Berries large, markedly oval, dark purplish-black, glossy, covered with light bloom, strongly persistent, firm; skin thick, tender, adherent; flesh green with a yellow tinge, translucent, very juicy, tender, fine-grained, vinous, mild; very good in quality. Seeds free, one to three, notched, long, brown.

Dracut Amber

(Labrusca)

Dracut Amber is representative of the red type of Labrusca. The fruit has no particular merit, its thick skin, coarse pulp, seeds and foxy taste all being objectionable. However, the vine is very hardy, productive, and ripens its fruit early so that this variety becomes valuable in locations where a vigorous, hardy, early grape is wanted. Asa Clement, Dracut, Massachusetts grew Dracut Amber from seed planted about 1855.

Vine vigorous, hardy, productive. Canes long, numerous, dark brown; nodes enlarged, flattened; tendrils continuous, long, bifid or trifid. Leaves large, thick; upper surface dark green, dull, smooth; lower surface pale green, cobwebby; lobes three to five with terminal one obtuse; petiolar sinus deep, narrow; basal sinus shallow, wide; teeth shallow. Flowers on plan of six, semi-fertile, mid-season.

Fruit early, season short. Clusters short, broad, cylindrical, irregular, rarely shouldered, compact; pedicel short, covered with warts; brush long, light yellowish-green. Berries medium to large, oval, dull pale red or dark amber, covered with thin bloom, soft; skin very thick, tender, adherent, astringent; flesh green, translucent, juicy, tough, very foxy; inferior in quality. Seeds adherent, two to five, large, broad, light brown.

Dutchess

(Vinifera, Labrusca, Bourquiniana? Æstivalis?)

Dutchess (Plate XIII) is not grown largely in commercial vineyards because of several faults, as: the vine is tender to cold; the berries do not ripen evenly; berries and foliage are susceptible to fungi; and in soils to which it is not adapted, berries and bunches are small. In spite of these defects, Dutchess should not be discarded by the grape-lover, for there are few grapes of higher quality. The grapes are sweet and rich, yet do not cloy the appetite; although of but medium size, they are attractive, being a beautiful amber color with distinctive dots; the flesh is translucent, sparkling, fine-grained and tender; the seeds are small, few and part readily from the pulp; the

skin is thin, yet tough enough for good keeping; and the bunches are large and compact when well grown. The variety is self-fertile and, therefore, desirable when only a few vines are wanted. The clusters are especially fine when bagged. A. J. Caywood, Marlboro, New York, grew Dutchess from seed of a white Concord seedling pollinated by mixed pollen of Delaware and Walter. The seed was planted in 1868.

Vine vigorous, an uncertain bearer. Canes dark brown with light bloom, surface roughened; nodes enlarged, flattened; internodes short; tendrils intermittent, short, bifid or trifid. Leaves irregular in outline; upper surface pale green, pubescent; leaf entire with terminus acute; petiolar sinus narrow; basal sinus shallow when present; lateral sinus medium in depth or a mere notch. Flowers self-fertile, open late; stamens upright.

Fruit mid-season, keeps and ships well. Clusters large, long, slender, tapering with a prominent single shoulder; pedicel slender, smooth; brush amber-colored. Berries of medium size, round, pale yellow-green verging on amber, some showing bronze tinge with thin bloom, persistent, firm; skin sprinkled with small dark dots, thin, tough, adherent; flesh pale green, translucent, juicy, fine-grained, tender, vinous, sweet, of pleasant flavor; quality high. Seeds free, one, two or occasionally three, small, short, sharp-pointed, brown.

Early Daisy

(Labrusca)

The qualities of Early Daisy render the variety more than commonplace. Its earliness commends it, the ripening period being eight or ten days earlier than Champion or Moore Early, making it one of the very earliest varieties. For a grape maturing at its season, it both keeps and ships well. Early Daisy would seem to be as desirable as Hartford or Champion. The variety originated with John Kready, Mount Joy, Pennsylvania, in 1874, as a seedling of Hartford.

Vine vigorous, hardy, produces fair crops. Canes of medium length, numerous, slender, reddish-brown; nodes enlarged, flattened; tendrils continuous, bifid. Leaves small, light green; upper surface rugose; lower surface slightly pubescent, cobwebby; lobes wanting or

faintly three; petiolar sinus deep, narrow; teeth shallow, narrow. Flowers nearly self-sterile.

Fruit early. Clusters small to medium, often blunt at ends, cylindrical, sometimes single-shouldered, compact; pedicel short, slender, smooth; brush reddish, slender. Berries of medium size, round, dull black, covered with heavy bloom, persistent; skin tough, purplish-red pigment; flesh tough, solid, aromatic, tart at the skin, acid at center; inferior in flavor and quality. Seeds numerous, adherent, of average size, dark brown.

Early Ohio

(Labrusca)

Early Ohio is remarkable, chiefly, in being one of the earliest commercial grapes. The fruit resembles that of Concord, of which it is probably a seedling. Notwithstanding many defects, Early Ohio is grown somewhat commonly, although its culture is on the wane. The variety was found in 1882 by R. A. Hunt, Euclid, Ohio, between rows of Delaware and Concord.

Vine weak, tender, usually unproductive. Canes short, slender, brown with a red tinge; nodes enlarged, flattened; internodes short; tendrils continuous, short, bifid. Leaves intermediate in size; upper surface light green, dull, smooth; lower surface pale green tinged with bronze, pubescent; lobes wanting or one to three, terminal one acute; petiolar sinus shallow, wide; basal sinus usually absent; lateral sinus shallow, narrow; teeth shallow. Flowers self-fertile, open in midseason; stamens upright.

Fruit very early, does not keep well. Clusters medium in size, tapering; pedicel slender with a few small warts; brush slender, tinged with red. Berries variable in size, round, purplish-black, glossy with heavy bloom, persistent, firm; skin adherent, astringent; flesh green, translucent, juicy, tough, aromatic; poor in quality. Seeds adherent, one to four, notched, brown with yellowish-brown tips.

Early Victor

(Labrusca, Bourquiniana?)

Early Victor is highest in quality of early black grapes. It is especially pleasing to those who object to the foxiness so

marked in Hartford and Champion. Were the season but a few days earlier and bunch and berry a little larger, Early Victor would be the best grape to start the grape season. The vines are hardy, healthy, vigorous and productive, with growth and foliage resembling Hartford, which is probably one of its parents, Delaware being the other. The bunches are small, compact, variable in shape and the berries are about the size and shape of those of Delaware. Its season is that of Moore Early or a little later, although, like many black grapes, the fruit colors before it is ripe and is often picked too green. Unfortunately the fruit is susceptible to black-rot and shrivels after ripening. John Burr, Leavenworth, Kansas, first grew Early Victor about 1871.

Vine vigorous, hardy, healthy, productive. Canes long, numerous, slender, dark brown, surface pubescent; nodes enlarged; internodes long; tendrils continuous, bifid, sometimes trifid. Leaves thick; upper surface dark green, smooth; lower surface white, heavily pubescent; lobes three to five, terminal one acute; petiolar sinus intermediate in depth and width; basal sinus shallow and wide when present; lateral sinus narrow. Flowers semi-sterile, open in mid-season; stamens upright.

Fruit very early, does not keep well. Clusters small, variable in shape, cylindrical, frequently single-shouldered, compact; pedicel short, covered with numerous small warts; brush wine-colored or pinkish-red. Berries small, round, dark purplish-black, dull with heavy bloom, persistent; skin thin, tough, adherent, contains much red pigment, astringent; flesh greenish-white, opaque, fine-grained, aromatic, vinous; good. Seeds adherent, one to four, broad, notched, blunt, dark brown.

Eaton

(Labrusca)

Eaton (Plate XIV) is a pure-bred seedling of Concord which it surpasses in appearance but does not equal in quality of fruit. The flesh is tough and stringy, and though sweet at the skin, is acid at the seeds and has the same foxiness that characterizes Concord, but with more juice and less richness, so that it is well

described as a "diluted" Concord. The grape-skin is very similar to that of Concord, and the fruit packs, ships and keeps about the same, perhaps not quite as well because of the greater amount of juice. The season is a few days earlier than Concord. The vine is similar in all characters to that of its parent. The grapes ripen unevenly, the flowers are self-sterile, and in some locations the vine is a shy bearer. The variety has not found favor with either grower or consumer. Eaton originated with Calvin Eaton, Concord, New Hampshire, about 1868.

Vine vigorous, hardy, healthy, productive. Canes thick, light brown with blue bloom; nodes enlarged, flattened; internodes short; tendrils continuous, long, bifid or trifid. Leaves large, round, thick; upper surface dark green; lower surface tinged with bronze, heavily pubescent; lobes three, terminal one acute; petiolar sinus shallow, wide; basal sinus usually lacking; lateral sinus shallow, narrow, often notched; teeth shallow. Flowers semi-sterile, early; stamens upright.

Fruit mid-season. Clusters large, short, broad, blunt, sometimes double-shouldered, compact; pedicel long, thick, smooth; brush slender, pale green. Berries large, round, black with heavy bloom, persistent, firm; skin tough, adherent, purplish-red pigment, astringent; flesh green, translucent, juicy, tough, stringy, foxy; fair in quality. Seeds adherent, one to four, broad, notched, plump, blunt.

Eclipse

(Labrusca)

Eclipse (Plate XV) is a seedling of Niagara and, therefore, a descendant of Concord which it resembles, differing chiefly in earlier fruit which is of better quality. Unfortunately, the bunches and berries are small. The vines are hardly surpassed by those of any other variety, being hardy, healthy and productive, qualities that should commend it for commercial vineyards. The ripe fruit hangs on the vines for some time without deterioration, and the grapes do not crack in wet weather. The crop ripens several days earlier than that of Concord.

Eclipse originated with E. A. Riehl, Alton, Illinois, from seed planted about 1890.

Vine vigorous, hardy, productive. Canes medium in length, dark reddish-brown; nodes enlarged; tendrils continuous, long, bifid. Leaves large; upper surface dark green; lower surface white with a bronze tinge, heavily pubescent; lobes wanting or three with terminal one acute; petiolar sinus deep, narrow; basal sinus usually lacking; lateral sinus narrow, often notched; teeth shallow, narrow. Flowers self-sterile, open in mid-season; stamens reflexed.

Fruit early, keeps well. Clusters of medium size, broad, tapering, frequently single-shouldered, compact; pedicel short, thick, covered with small warts; brush long, pale green. Berries, large, oval, dull black with abundant bloom, persistent, firm; skin tender, slightly adherent, astringent; flesh pale green, translucent, juicy, tender, fine-grained, foxy, sweet; good. Seeds free, one to four, short, broad, distinctly notched, blunt, brown.

Eden

(Rotundifolia, Munsoniana?)

Eden is of value as a general-purpose grape for the South and is interesting as one of the few supposed hybrids with *V. rotundifolia*. It is probably a hybrid between the species named and *V. Munsoniana*, another southern wild grape. The vine is exceedingly vigorous and productive and thrives on clay soils, whereas most other Rotundifolias can be grown successfully only on sandy lands. Eden was found some years ago on the premises of Dr. Guild, near Atlanta, Georgia.

Vine very vigorous, productive, healthy and bearing a dense canopy of foliage. Canes darker in color than most other Rotundifolias. Leaves of medium size and thickness, longer than wide; petiolar sinus wide; marginal teeth rounded; leaf-tip blunt. Flowers perfect.

Fruit early, distinct first and second crops, ripens uniformly. Clusters large, loose, bearing from five to twenty-five berries which adhere fairly well to the pedicels. Berries round, one-half inch in diameter, dull black, faintly specked; skin thin, tender; flesh soft, juicy, pale green, sprightly; good in quality.

Eldorado

(Labrusca, Vinifera)

The fruit of Eldorado is delicately flavored, with a distinct aroma and taste and ripens about with that of Moore Early — a time when there are few other good white grapes. The vines inherit most of the good qualities of Concord, one of its parents, excepting ability to set large crops. Even with cross-pollination, Eldorado sometimes fails to bear and is not worth growing unless planted in a mixed vineyard. The clusters are so often small and straggling under the best conditions that the variety cannot be recommended highly to the amateur; yet its delightful flavor and its earliness commend it. J. H. Ricketts, Newburgh, New York, grew Eldorado about 1870 from seed of Concord fertilized by Allen's Hybrid.

Vine vigorous, hardy, an uncertain bearer. Canes long, few, thick, flattened, bright reddish-brown; nodes enlarged, flattened; tendrils intermittent, rarely continuous, bifid or trifid. Leaves large to medium, irregularly round, dark green; upper surface rugose on older leaves; lower surface tinged with brown, pubescent; lobes wanting or faintly three; petiolar sinus deep; teeth shallow. Flowers self-sterile, open late; stamens reflexed.

Fruit early, keeps well. Clusters do not always set perfectly and are variable in size, frequently single-shouldered; pedicel short, slender, smooth; brush short, yellow. Berries large, round, yellowish-green changing to golden yellow, covered with thin bloom; flesh tender, foxy, sweet, mild, high flavored; good to very good in quality. Seeds intermediate in size and length, blunt, yellowish-brown.

Elvira

(Vulpina, Labrusca)

Although it has never attained popularity in the North, Elvira (Plate XVI), after its introduction into Missouri about forty years ago, reached the pinnacle of popularity as a wine-grape in the South. The qualities which commended it were:

great productiveness; earliness, ripening in the North with Concord; exceedingly good health, being almost free from fungal diseases; great vigor, as shown by a strong, stocky growth and ample foliage; and almost perfect hardiness even as far north as Canada. Its good qualities are offset by two defects: thin skin which bursts easily, thus wholly debarring it from distant markets; and flavor and appearance not sufficiently good to make it a table-grape. Elvira originated with Jacob Rommel, Morrison, Missouri, from seed of Taylor.

Vine vigorous, hardy, healthy, productive. Canes numerous, dark brown; nodes flattened; internodes short; tendrils continuous, trifid or bifid. Leaves large, thin; upper surface light green, pubescent, hairy; lobes wanting or one to three with terminus acute; petiolar sinus deep, narrow, sometimes closed and overlapping; basal sinus usually lacking; lateral sinus shallow, often notched; teeth deep, wide. Flowers self-fertile, open early; stamens upright.

Fruit mid-season, does not keep well. Clusters short, cylindrical, usually single-shouldered, compact; pedicel smooth; brush short, greenish-yellow with brown tinge. Berries medium in size, round, green with yellow tinge, dull with thin bloom, firm; skin very thin, tender, adherent, astringent; flesh green, juicy, fine-grained, tender, foxy, sweet; fair in quality. Seeds free, one to four, medium to large, blunt, plump, dark brown.

Emperor

(Vinifera)

Emperor is one of the standard shipping grapes of the Pacific slope, being one of the mainstays of the interior valleys. On the coast and in southern California, it is irregular in bearing, and on the coast the fruits often fail to ripen. It is chiefly grown in the San Joaquin Valley. It could hardly be expected to ripen even in the most favored grape regions in the East. The following brief description is compiled:

Vine strong, healthy and productive. Leaves very large, with five shallow lobes; teeth short and obtuse; light green in color;

glabrous above, wooly beneath. Bunches very large, loose, sometimes inclined to be straggling, long-conical. Berries large, dull purple, oval; flesh firm and crisp; skin thick; flavor and quality good. Ripens late and keeps and ships well.

Empire State

(Vulpina, Labrusca, Vinifera)

Empire State (Plate XVII) competes with Niagara and Diamond for supremacy among green grapes. The variety is as vigorous in growth, as free from parasites, and on vines of the same age is as productive, but is less hardy, and the grapes are not as attractive in appearance as those of the other varieties named. In particular, the clusters are small in some localities, a defect which can be overcome only by severe pruning or by thinning. The quality is very good, approaching the flavor of the Old World grapes, its slight wild taste suggesting one of the Muscats. Empire State ripens early, hangs long on the vine and keeps well after picking without losing flavor. This grape originated with James H. Ricketts, Newburgh, New York, bearing fruit first in 1879.

Vine vigorous, somewhat tender. Canes short, few, slender, brownish; nodes enlarged; internodes short; tendrils intermittent, bifid. Leaves small; upper surface light green, glossy, smooth or somewhat rugose; lower surface tinged with bronze, heavily pubescent; lobes three to five when present, terminal one acuminate; petiolar sinus deep, narrow, often closed and overlapping; basal sinus variable in depth and width; lateral sinus deep, narrow, often enlarged at base; teeth deep, wide. Flowers self-fertile, open late; stamens upright.

Fruit mid-season, keeps well. Clusters large, long, slender, cylindrical, frequently single-shouldered, compact; pedicel slender with small warts; brush short, light green. Berries medium or small, round, pale yellowish-green, covered with thin bloom, persistent, firm; skin thick, adherent to the pulp, slightly astringent; flesh pale yellowish-green, translucent, juicy, fine-grained, tender, agreeably flavored; good to very good. Seeds adherent, one to four, small, broad, notched, short, blunt, plump, brown.

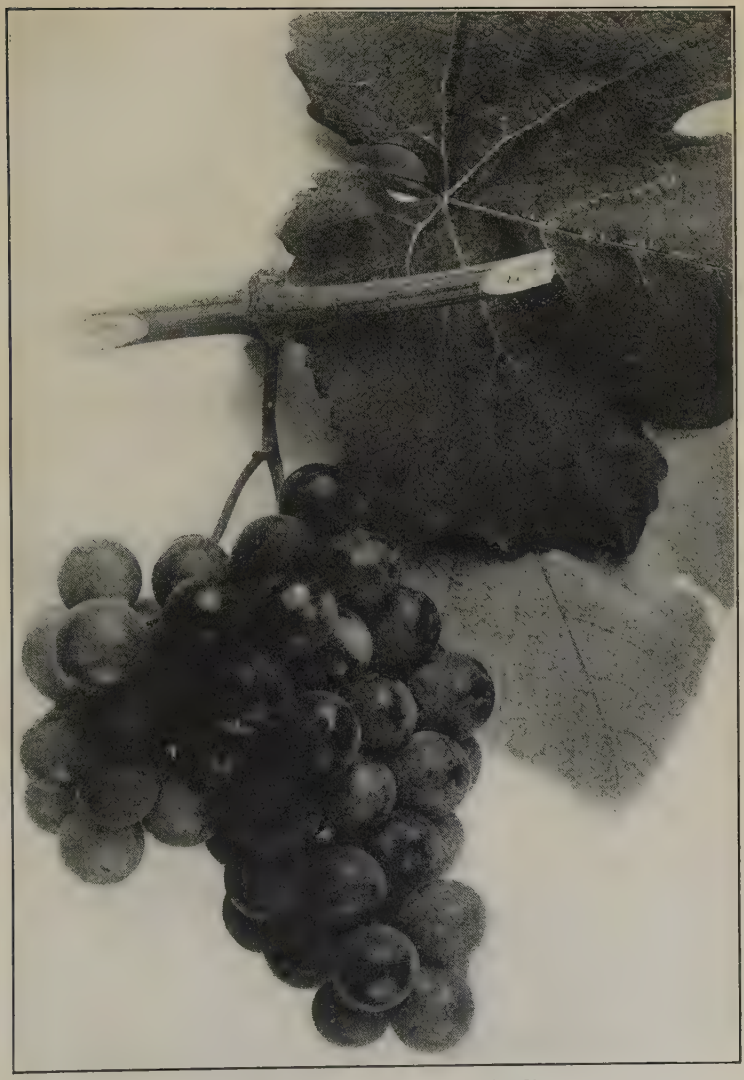

PLATE XXVII. — Salem ($\times \frac{2}{3}$).

Etta

(Vulpina, Labrusca)

In appearance, taste and texture of fruit, Etta is very similar to Elvira, of which it is a seedling. The small, yellow clusters which characterize Elvira are reproduced in Etta, which differs chiefly in having a shoulder quite as large as the main bunch itself and in having a better flavor, lacking the slight foxiness of Elvira. The vine is very vigorous, hardy, and is productive to a fault. The fruit ripens with that of Catawba. The tendency of Elvira to crack and overbear influenced the originator of that variety, Jacob Rommel, Morrison, Missouri, to try for a grape without these faults, and the result was Etta from seed of Elvira. The fruit was first exhibited in 1879.

Vine very vigorous, hardy, productive. Canes long, numerous, light to dark brown; tendrils continuous, bifid. Leaves large, thick; upper surface dark green, glossy, smooth; lower surface pale green, somewhat cobwebby. Flowers self-fertile, early; stamens upright.

Fruit late, keeps well. Clusters small, short, broad, irregularly cylindrical, usually with a short, single shoulder but sometimes so heavily shouldered as to form a double bunch, very compact. Berries small, round, pale green, dull with thin bloom, shattering when overripe, firm; skin thin, tender; flesh juicy, fine-grained, tough, stringy, slightly foxy, mild; fair in quality. Seeds free, long, blunt, brown.

Eumelan

(Labrusca, Vinifera, Æstivalis)

Washington

The good qualities of Eumelan are: vines above the average in vigor, hardiness and productiveness; clusters and berries well formed, of good size and handsome color; flesh tender, dissolving into wine-like juice under slight pressure; and pure flavor, rich, sweet, vinous. The season is early, yet the fruit keeps much better than that of most other grapes maturing

with it and becomes, therefore, a mid-season and late grape. The defects of the variety are susceptibility to mildew, self-sterile flowers and difficulty in propagation. The latter character has greatly hindered its culture, as the vines can be secured only at extra expense and nurserymen are loath to grow the variety at all. Eumelan may be recommended to amateur growers. It is a chance seedling which grew from seed, about 1847, in the yard of a Mr. Thorne, Fishkill Landing, New York.

Vine vigorous, hardy, productive. Canes numerous, covered with bloom; nodes enlarged; internodes short; tendrils intermittent, long, trifid or bifid. Leaves large; upper surface dark green, glossy, smooth; lower surface pale green, smooth; lobes usually three with terminal one acute; petiolar sinus deep, variable in width; basal sinus usually lacking; lateral sinus shallow, narrow; teeth shallow. Flowers self-sterile, open in mid-season; stamens reflexed.

Fruit early, keeps until late winter. Clusters long, slender, tapering, often with a long, loose, single shoulder; pedicel short, slender with a few small warts; brush short, stubby, pale green. Berries of medium size, round, black, glossy with thin bloom, persistent, firm; skin tough, adherent with wine-colored pigment, astringent; flesh dark green, juicy, fine-grained, tender, stringy, spicy and aromatic, sweet; good. Seeds adherent, one to four, large, wide, blunt, plump, brown.

Faith

(Vulpina, Labrusca)

Although spoken of as a desirable grape in some regions, Faith is of little value in most localities. The fruit is unattractive in appearance, and the quality is not high. If the variety has any preëminently good character, it is productiveness. The blossoms put forth so early that they often suffer from spring frosts. Faith is of the same breeding as Etta and from the same originator, Jacob Rommel, Morrison, Missouri, both having come from seed of Elvira.

Vine vigorous, hardy, healthy, productive. Canes long, numerous, thick, cylindrical; nodes prominent; internodes long; tendrils continuous, bifid. Leaves large, dark green; upper surface dark green,

dull; lower surface grayish-green, thinly pubescent; lobes wanting or faint; teeth shallow, wide. Flowers self-sterile to partly self-fertile, open early; stamens upright.

Fruit early, does not keep well. Clusters medium in size, variable in length, usually slender, often heavily single-shouldered, loose; pedicel short, slender, warty; brush pale green, slender. Berries small, round, dull green, frequently with a yellow tinge changing to pale amber, with abundant bloom, persistent, soft; skin thin, adherent, astringent; flesh juicy, tender, agreeably flavored; fair to good in quality. Seeds numerous, broad, dark brown.

Feher Szagos

(Vinifera)

This variety succeeds rather well at Geneva, New York, bearing fruits of excellent quality. It has two defects, dull color of the berries and irregular bunches. It is worth trying in the East. Feher Szagos is said to make a very good raisin in California and usually appears in lists of table-grapes for that state.

Vines vigorous, somewhat uncertain bearers. Opening leaves pubescent, red along the edges and a tinge of red on the upper surface. Flowers have upright stamens. Fruit usually ripens the first week in October and does not keep well in storage; clusters large to medium, broad, loose, frequently irregular because of poor setting of fruit; berries large, oval to elliptical, rather dull green, with thin bloom; skin thick, tender, neutral; flesh greenish, translucent, juicy, meaty, tender, sweet; quality of the best; seeds free.

Fern Munson

(Lincecumii, Vinifera, Labrusca)

Admirable, Fern, Hilgarde, Munson's No. 76

Fern Munson is a southern grape not adapted to northern regions, 40° north latitude being its limit of adaptation. The fruits show some very good characters, as attractive appearance, agreeable quality and unobjectionable seeds and skin. The

vines are vigorous and productive, but the foliage is not healthy although very abundant. This variety originated with T. V. Munson, Denison, Texas, from seed of Post-oak with mixed pollen. The seed was planted in 1885, and the variety was introduced by the originator in 1893.

Vine vigorous, doubtfully hardy. Canes long, numerous, thick, dark brown with a faint red tinge; tendrils intermittent, bifid. Leaves large, thick; upper surface rugose and heavily wrinkled; lower surface dull, pale green with a bronze tinge, faintly pubescent. Flowers semi-fertile, open very late; stamens upright.

Fruit late, keeps well. Clusters large, irregularly tapering, usually single-shouldered, often with many abortive fruits. Berries large, round, slightly flattened, dark purplish-black, glossy, covered with thin bloom, strongly persistent, firm; skin thin, tough, astringent; flesh juicy, tough, firm, fine-grained, vinous, briskly subacid; good. Seeds adherent, broad.

Flame Tokay

(Vinifera)

This is the leading shipping grape of the Pacific slope where it is everywhere grown under the name "Tokay," with several modifying terms, as "Flame," "Flame-colored" and "Flaming." The fruit is not especially high in quality nor attractive in appearance, but it ships and keeps well, qualities making it popular in commercial vineyards. The description is compiled.

Vine very vigorous, luxuriant in growth of canes, shoots and leaves; very productive; wood dark brown, straight with long joints. Leaves dark green with a brown tinge; lightly lobed. Bunches very large, sometimes weighing eight or nine pounds, moderately compact; shouldered. Berries large, oblong, red when mature, covered with lilac bloom; flesh firm, crisp, sweet; quality good. Season late, keeps and ships well.

Flowers

(Rotundifolia)

Flowers is a late, dark-colored Rotundifolia very popular in the Carolinas. The variety is noted for its vigorous and

productive vines, its large fruit-clusters and grapes that cling in the cluster unusually well for a variety of this species. The crop ripens in North Carolina in October and November. The fruit is valuable only for wine and grape-juice, having little to recommend it for dessert purposes. Flowers was found in a swamp near Lamberton, North Carolina, more than a hundred years ago by William Flowers. Improved Flowers, probably a seedling of Flowers, was found near Whiteville, North Carolina, about 1869. It differs from its supposed parent in having a more vigorous and productive vine and larger clusters, the berries of which cling even more tenaciously.

Vine vigorous, healthy, upright, open, very productive. Canes long, slender, numerous. Leaves variable but average medium in size, longer than broad, pointed, cordate, thick, dark green, smooth, leathery; margins sharply serrate; flowers perfect.

Fruit very late, keeps well. Clusters, large, consisting of ten to twenty-five berries. Berries large, round-oblong, purple or purplish-black, clinging well to the cluster-stem; skin thick, tough, faintly marked with dots; pulp white, lacking in juice, hard, sweetish, austere in flavor; poor for a table-grape but excellent for grape-juice.

Gaertner

(Vinifera, Labrusca)

The berries and clusters of Gaertner are large and handsomely colored, making a very showy grape. The plant is vigorous, productive and as hardy as any of the hybrids between Labrusca and Vinifera. In view of these qualities, Gaertner has not received the attention it deserves, probably because it is more capricious as to soils than some others of its related hybrids. As a market grape, the variety has the faults of ripening unevenly and of shipping poorly. The fruit keeps well and this, with the desirable qualities noted, makes it an excellent grape for the home vineyard. Gaertner is often compared with Massasoit, the two varieties being very similar

in fruit characters, but Gaertner is of distinctly better quality than Massasoit. The variety originated with E. S. Rogers, Salem, Massachusetts. It was first mentioned about 1865.

Vine vigorous, hardy except in severe winters, productive. Canes long, dark reddish-brown, surface covered with thin bloom; tendrils continuous, bifid or trifid. Leaves medium in size, round; upper surface dark green; lower surface pale green, pubescent. Flowers self-sterile, open late; stamens reflexed.

Fruit mid-season, matures unevenly, keeps only fairly well. Clusters medium in size, short, cylindrical, usually with a single shoulder but sometimes double-shouldered, loose with many abortive fruits. Berries large, round-oval, light to dark red, glossy, covered with bloom, persistent; skin thin, tender; flesh pale green, juicy, fine-grained, tough, stringy, agreeably vinous; good to very good. Seeds free, large, broad, distinctly notched, brown.

Geneva

(Vinifera, Labrusca)

Geneva is surpassed by so many other grapes of its season in quality that it has never become popular, although it has much to recommend it. The vine is vigorous and productive, although not quite hardy, and the berries and clusters are attractive; the fruit is nearly transparent and there is so little bloom that the grapes are a lustrous green or iridescent in sunlight; the berries cling well to the stem and the fruit keeps exceptionally well. Geneva originated with Jacob Moore, Brighton, New York, from seed planted in 1874 from a hybrid vine fertilized by Iona.

Vine vigorous, healthy, productive. Canes covered with thin bloom; tendrils intermittent or continuous, bifid or trifid. Leaves medium in size; upper surface light green, dull; lower surface grayish-white, pubescent; lobes three to five, acute; petiolar sinus, shallow, wide; teeth shallow, narrow. Flowers self-sterile or partly fertile, open late; stamens upright.

Fruit mid-season, ships well and keeps into the winter. Clusters large, blunt at the ends, usually not shouldered, with many abortive fruits; pedicel long, slender, smooth; brush long, green. Berries large, oval, dull green changing to a faint yellow with thin bloom;

skin thick, tough, unpigmented; flesh pale green, tender, soft, vinous, sweet at skin but tart at center; fair to good. Seeds of medium size and length.

Goethe

(Vinifera, Labrusca)

Of all Rogers' hybrids, Goethe shows Vinifera characters most, resembling in appearance the White Malaga of Europe, and not falling far short of the best Old World grapes in quality. But the variety is difficult to grow, especially where the seasons are not long enough for full maturity. The vine is vigorous to a fault; it is fairly immune to mildew, rot and other diseases; and, where it succeeds, the vines bear so freely that thinning becomes a necessity. Added to high quality, which makes it an excellent table-grape, Goethe keeps well. Goethe was first mentioned in 1858 under the name of Rogers' No. 1.

Vine vigorous, hardy. Canes short, dark brown; nodes enlarged, flattened; internodes short; tendrils continuous or intermittent, long, bifid to trifid. Leaves irregularly round, thin; upper surface light green, glossy; lower surface pale green, pubescent; leaf usually not lobed, terminus broadly acute; petiolar sinus narrow, closed and overlapping; basal sinus usually lacking; lateral sinus shallow, often a notch; teeth shallow, narrow. Flowers partly self-fertile, open in mid-season; stamens upright.

Fruit late, keeps well. Clusters short, broad, tapering, frequently single-shouldered, usually two bunches to shoot; pedicel long, thick with numerous conspicuous warts; brush long, slender, yellowish-brown. Berries very large, oval, pale red covered with thin bloom, persistent; skin thin, tender, adherent, faintly astringent; flesh pale green, translucent, tender with Vinifera flavor; very good. Seeds adherent, one to three, large, long, notched, blunt, brown.

Gold Coin

(Æstivalis, Labrusca)

In the South, where alone it thrives, Gold Coin is a handsome market variety of very good quality. The vines are productive and are unusually free from attacks of fungal diseases. The

variety originated with T. V. Munson, Denison, Texas, from seed of Cynthiana or Norton pollinated by Martha and was introduced by the originator in 1894.

Vine vigorous, hardy, productive. Canes slender, numerous; tendrils continuous, sometimes intermittent, trifid or bifid. Leaves medium in size; upper surface light green, slightly rugose; lower surface pale green, tinged with bronze, heavily pubescent. Flowers self-fertile; stamens upright.

Fruit late mid-season, keeps long. Clusters medium to small, usually single-shouldered. Berries large, round-oval, yellowish-green with a distinct trace of reddish-amber, with thin bloom, usually persistent; skin covered with small, scattering brown dots, thin, tough; flesh faintly aromatic, tart from skin to center; good. Seeds free, numerous, medium in size.

Green Early

(Labrusca, Vinifera)

Green Early is a white grape coming in season with Winchell, which surpasses it in most characters, quality in particular. Green Early was found in 1885, growing by the side of a ditch near a Concord vineyard, on land belonging to O. J. Green, Portland, New York.

Vine vigorous, hardy, productive. Canes variable in length and thickness, dark reddish-brown; nodes enlarged, flattened; internodes short; tendrils continuous, sometimes intermittent, bifid or trifid. Leaves variable in size, medium green; upper surface dark green, glossy; lower surface pale green, pubescent; lobes wanting or faintly five; teeth shallow, narrow; stamens upright.

Fruit early, does not keep well. Clusters variable in size, length and breadth, sometimes single-shouldered, variable in compactness. Berries large, oval, light green tinged with yellow, with thin bloom, persistent, soft; skin thin, tender, inclined to crack; flesh tough and aromatic, sweet at skin but acid at center; fair in quality. Seeds medium in size, length and breadth, sharp-pointed.

Grein Golden

(Vulpina, Labrusca)

Grein Golden is very similar to Riesling, but the vine is much stronger in growth. For a variety of the Taylor group, both

cluster and berry are large and uniform, which, with the attractive color of the berries, make it a most handsome fruit. The flavor, however, is not at all pleasing, being an unusual commingling of sweetness and acidity very disagreeable to most palates. The quality of the fruit condemns it for table use, although it is said to make a very good white wine. Nicholas Grein, Hermann, Missouri, first grew Grein Golden about 1875.

Vine vigorous, hardy, productive. Canes long, numerous, slender, dark reddish-brown; nodes enlarged, flattened; internodes long; tendrils intermittent, trifid or bifid. Leaves large, thick; upper surface dark green, dull, smooth; lower surface pale green, lightly pubescent; lobes lacking or one to three with terminus acute; petiolar sinus deep, narrow; basal sinus usually lacking; lateral sinus shallow, wide, obscure; teeth deep. Flowers self-sterile, open in mid-season; stamens reflexed.

Fruit mid-season. Clusters large, long, broad, tapering, irregular, often heavily single-shouldered, loose; pedicel with a few inconspicuous warts; brush slender, pale green. Berries uniform in size, large, round, golden yellow, glossy with thin bloom, persistent; skin very thin, tender; flesh green, translucent, very juicy, tender, vinous; good. Seeds free, one to four, broad, plump, light brown.

Gros Colman

(Vinifera)

Dodrelabi

Gros Colman has the reputation of being the handsomest black table-grape grown. It is one of the favorite hot-house grapes in England and eastern America and is commonly grown out of doors in California. The variety is remarkable for having the largest berries of any round grape, borne in immense bunches, and for the long-keeping qualities, although the tender skins sometimes crack. The following description is compiled:

Vine vigorous, healthy and productive; wood dark brown. Leaves very large, round, thick, but slightly lobed; teeth short and blunt;

glabrous above, woolly below. Bunches very large, short, well filled but rather loose; berries very large, round, dark blue; skin thick but tender; flesh firm, crisp, sweet and good; quality not of the highest. Season late and the fruits keep long.

Hartford

(Labrusca)

The vine of Hartford may be well characterized by its good qualities, but the fruit is best described by its faults, because of which the variety is passing out of cultivation. The plants are vigorous, prolific, healthy and the fruit is borne early in the season. The canes are remarkable for their stoutness and for the crooks at the joints. The bunches are not unattractive, but the quality of the fruit is low, the flesh being pulpy and the flavor insipid and foxy. The berries shell badly on the vine and when packed for shipping, so that the fruit does not ship, pack or keep well. The grapes color long before ripe, and the flowers are only partly self-fertile, so that in seasons when there is bad weather during blooming time the clusters are loose and straggling. The original vine of Hartford was a chance seedling in the garden of Paphro Steele, West Hartford, Connecticut. It fruited first in 1849.

Vine vigorous, very productive. Canes long, dark brown, covered with pubescence; nodes enlarged, flattened; internodes short; tendrils continuous, long, bifid. Leaves large, thick; upper surface dark green, dull, rugose; lower surface pale green, thinly pubescent; lobes variable; petiolar sinus deep, narrow; basal sinus usually lacking; lateral sinus shallow, narrow; teeth shallow. Flowers partly self-fertile, open in mid-season; stamens upright.

Fruit early. Clusters medium in size, long, slender, tapering, irregular, often with a long, large, single shoulder, loose; pedicel short with a few small warts; brush greenish. Berries medium in size, round-oval, black, covered with bloom, drop badly; skin thick, tough, adherent, contains much purplish-red pigment, astringent; flesh green, translucent, juicy, firm, stringy, foxy; poor in quality. Seeds free, one to four, broad, dark brown.

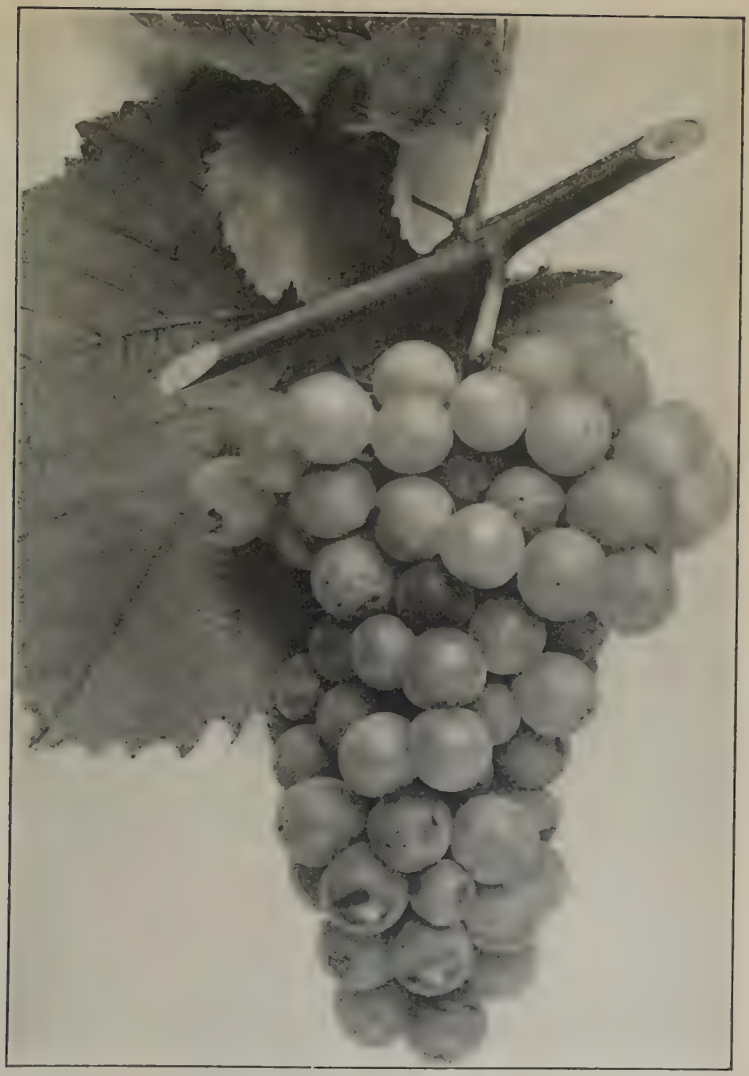

PLATE XXVIII. — Triumph ($\times \frac{2}{3}$).

Hayes

(Labrusca, Vinifera)

In 1880, the Massachusetts Horticultural Society awarded a certificate of merit to Hayes for high quality in fruit. This brought it prominently before grape-growers and for a time it was popular, but when better known several defects became apparent. The vine is hardy and vigorous, but the growth is slow and the variety is a shy bearer. Both bunches and berries are small, and the crop ripens at a time, a week or ten days earlier than Concord, when there are many other good green grapes. Excellent though it is in quality, the variety is hardly worth a place in any vineyard. John B. Moore, Concord, Massachusetts, is the originator of Hayes. It is a seedling of Concord out of the same lot of seedlings as Moore Early. It was first fruited in 1872.

Vine variable in vigor and productiveness, hardy and healthy. Canes numerous, slender; nodes enlarged, flattened; internodes short; tendrils intermittent, bifid or trifid. Leaves uniform in size; upper surface dark green; lower surface pubescent; lobes one to three; teeth shallow, small. Flowers almost self-sterile, open medium late; stamens upright.

Fruit early, keeps well. Clusters variable in size and length, often single-shouldered; pedicel long, slender; brush small, pale green. Berries medium in size, round, greenish-yellow, covered with thin bloom, persistent; skin thin, tender with a few small reddish-brown dots; flesh fine-grained, tender, vinous, sweet at the skin, agreeably tart at center, mild; good. Seeds few, of average size, short, plump, brown.

Headlight

(Vinifera, Labrusca, Bourquiniana)

Headlight is more desirable for southern than for northern vineyards, yet it is worthy of trial in the North. Its meritorious characters are: productiveness, outyielding Delaware, with

which it competes; disease-resistant foliage and vines; more than average vigor of vine; high quality of fruit, being almost the equal of Delaware in flavor and having tender, melting pulp which readily parts from the seeds; and earliness, ripening before Delaware and hanging on the vines or keeping after being picked for some time without deterioration. The originator of Headlight, T. V. Munson, states that the variety came from seed of Moyer fertilized by Brilliant. The seed was planted in 1895 and the grape was introduced in 1901.

Vine vigorous, hardy, very productive. Canes short, few in number, slender, reddish-brown; nodes enlarged; internodes short; tendrils continuous, short, bifid, very persistent. Leaves small, thick; upper surface light green, dull, smooth; lower surface pale green, pubescent; lobes one to three with terminus obtuse; petiolar sinus intermediate in depth and width; basal sinus usually lacking; lateral sinus shallow, narrow; teeth shallow. Flowers self-sterile, open in mid-season; stamens reflexed.

Fruit early, keeps well. Clusters small, short, tapering, frequently single-shouldered, compact; pedicel short, slender, covered with a few small warts; brush yellowish-brown. Berries small, round, dark red with thin bloom, persistent, firm; skin tough, adherent, astringent; flesh green, translucent, very juicy, tender, fine-grained, vinous, sweet; very good. Seeds free, one to three, small, light brown.

Herbemont

(Bourquiniana)

Bottsi, Brown French, Dunn, Herbemont's Madeira, Hunt, Kay's Seedling, McKee, Neal, Warren, Warrenton

In the South, Herbemont holds the same rank as Concord in the North. The vine is fastidious as to soil, requiring a well-drained warm soil, and one which is abundantly supplied with humus. Despite these limitations, this variety is grown in an immense territory, extending from Virginia and Tennessee to the Gulf and westward through Texas. The vine is remarkably vigorous, being hardly surpassed in this character by any

other of our native grapes. The fruits are attractive because of the large bunch and the glossy black of the small berries, and are borne abundantly and with certainty in suitable localities. The flesh characters of the fruit are good for a small grape, neither flesh, skin nor seeds being objectionable in eating; the pulp is tender, juicy, rich, sweet and highly flavored. The ample, lustrous green foliage makes this variety one of the attractive ornamental plants of the South. Herbemont is known to have been in cultivation in Georgia before the Revolutionary War, when it was generally called Warren and Warrenton. In the early part of the last century, it came to the hands of Nicholas Herbemont, Columbia, South Carolina, whose name it eventually took.

Vine very vigorous. Canes long, strong, bright green, with more or less purple and heavy bloom; internodes short; tendrils intermittent, bifid or trifid. Leaves large, round, entire, or three to seven-lobed, nearly glabrous above and below; upper surface clear green; lower surface lighter green, glaucous. Flowers self-fertile.

Fruit very late. Clusters large, long, tapering, prominently shouldered, compact; pedicels short with a few large warts; brush pink. Berries round, small, uniform, reddish-black or brown with abundant bloom; skin thin, tough; flesh tender, juicy; juice colorless or slightly pink, sweet, sprightly. Seeds two to four, small, reddish-brown, glossy.

Herbert

(Labrusca, Vinifera)

In all that constitutes a fine table-grape, Herbert (Plate XVIII) is as near perfection as any American variety. For a Vinifera-Labrusca hybrid, the vine is vigorous, hardy and fruitful, ranking in these respects above many pure-bred Labruscas. While the fruit ripens with Concord, it keeps much later and packs and ships better. The variety is self-sterile and must be set near other varieties. Herbert is deserving attention from commercial growers who supply a

discriminating market, and its many good qualities give it high place as a garden grape. The variety is one of Rogers' hybrids, named Herbert in 1869.

Vine very vigorous, productive. Canes long, numerous, thick, dark brown; nodes enlarged, flattened; internodes long; tendrils intermittent, long, bifid or trifid. Leaves large, round; upper surface dark green, dull, smooth; lower surface pale green with some pubescence; leaf entire, terminus obtuse; petiolar sinus deep, narrow, closed, overlapping; basal and lateral sinuses lacking; teeth shallow. Flowers self-sterile, open in mid-season; stamens reflexed.

Fruit mid-season, keeps well. Clusters large, broad, tapering, two to three clusters per shoot, heavily single-shouldered, loose; pedicel thick with small russet warts; brush yellowish-green. Berries large, round-oval, flattened, dull black, covered with thick bloom, persistent, firm; skin thick, tough, adherent, astringent; flesh light green, translucent, juicy, tender, fine-grained; very good. Seeds adherent, three to six, large, broad, notched, long with swollen neck, blunt, brown with yellow tips.

Hercules

(Labrusca, Vinifera)

Hercules is characterized by very large berries, fruit handsomely colored and cluster large and well-formed. The flavor, while not of the best, is good. Added to the desirable qualities of the fruit, the vines are hardy, vigorous and productive. These good characters, however, cannot make up for the several defects of the variety. The grapes drop and crack badly and the pulp is tough and adheres too firmly to the seed for a dessert grape, so that the variety is worthless except for breeding purposes. Hercules was introduced by G. A. Ensenberger, Bloomington, Illinois, about 1890; its parentage is unknown.

Vine very vigorous, hardy, very productive. Canes long, dark reddish-brown; nodes enlarged, flattened; internodes long; tendrils continuous, bifid. Leaves large; upper surface light green, glossy, smooth; lower surface grayish-green, pubescent; lobes one to three, terminus acute; petiolar sinus deep, narrow; basal sinus usually

absent; lateral sinus shallow; teeth shallow. Flowers self-sterile, open in mid-season; stamens reflexed.

Fruit mid-season, keeps well. Clusters very large, broad, tapering, one to three clusters per shoot, compact; brush pale green. Berries very large, round, black, glossy with heavy bloom, firm; skin adherent, astringent; flesh green, translucent, juicy, very tough, coarse, stringy, foxy; fair in quality. Seeds adherent, one to five, large, broad, deeply notched, blunt, brown.

Hicks

(Labrusca)

Hicks is a remarkably good grape and were it not that the fruit is almost identical with that of Concord, ripening with it or a little earlier, it would have a place in the viticulture of the country. However, since it was introduced some years ago and has not found great favor with growers, it seems that it cannot make headway against Concord, with which it must compete. In many localities the vines are more prolific than those of Concord and of stronger growth. Hicks was introduced in 1898 by Henry Wallis, Wellston, Missouri, who states that it is a chance seedling sent from California about 1870 to Richard Berry, a nurseryman of St. Louis County, Missouri.

Vine very vigorous, hardy, very productive. Canes medium to long, numerous, reddish-brown, covered with thin bloom; tendrils continuous, bifid or trifid. Leaves large, thick; upper surface dark green, glossy; lower surface white, changing to a heavy bronze, strongly pubescent. Flowers self-fertile, open early; stamens upright.

Fruit mid-season, keeps well. Clusters large, long, broad, tapering, often single-shouldered. Berries large, round, purplish-black with heavy bloom, shatter when overripe, firm; skin tender with dark wine-colored pigment; flesh green, juicy, tough, fine-grained, faintly foxy; good. Seeds adherent, large, short, broad, blunt, brown.

Hidalgo

(Vinifera, Labrusca, Bourquiniana)

The grapes of Hidalgo are rich, sweet, delicately flavored, and with color, size and form of berry and bunch so well com-

bined as to make the fruits singularly handsome. The skin is thin but firm and the variety keeps and ships well. The vines, however, are doubtfully hardy, variable in vigor and not always fruitful. While Hidalgo may not prove of value for the commercial vineyard, in favorable situations it may give a supply of choice fruit for the amateur. The parentage of Hidalgo, as given by its originator, T. V. Munson, is Delaware, Goethe and Lindley. The variety was introduced by the originator in 1902.

Vine variable in vigor, hardiness and productiveness. Canes thick, dark reddish-brown; nodes enlarged, flattened; tendrils intermittent or continuous, bifid or trifid. Leaves large, irregularly round, thick; upper surface light green, dull, rugose; lower surface pale green, bronzed, heavily pubescent; lobes three when present; petiolar sinus narrow, sometimes closed and overlapping; basal sinus wanting; lateral sinus shallow, narrow; teeth very shallow, narrow. Flowers semi-fertile, open after mid-season; stamens upright.

Fruit mid-season, keeps and ships well. Clusters large, long, slender, cylindrical, often blunt, not shouldered, one to two bunches per shoot, compact; pedicel long, slender with small warts; brush yellowish-green with brown tinge. Berries large, oval, greenish-yellow, glossy with thin bloom, persistent, firm; skin thin, tough, adherent, astringent; flesh green, transparent, juicy, tender, melting, aromatic, sweet; very good to best. Seeds free, two to four, large, plump, light brown.

Highland

(Vinifera, Labrusca)

Few varieties of black grapes equal Highland in appearance and quality of fruit. When given good care under favorable conditions, the bunches are unusually large and handsome in appearance, sometimes attaining a weight of two pounds, and bear beautiful bluish-black berries with the fine flavor and tender texture of Jura Muscat, one of its parents. The flesh is solid, firm and the fruit keeps and ships well. The vine is vigorous, productive to a fault but is doubtfully hardy. Where the climate is temperate and the season long enough for the

vine and fruit of Highland to develop, this is one of the choicest grapes for the amateur. The variety originated about the close of the Civil War with J. H. Ricketts, Newburgh, New York, from seed of Concord fertilized by Jura Muscat.

Vine variable in vigor, productive, healthy. Canes long, numerous, dark brown with thin bloom; nodes enlarged; internodes long; tendrils intermittent, bifid or trifid. Leaves large; upper surface dark green, dull, rugose; lower surface grayish-green, pubescent; lobes one to five, terminal one acute; petiolar sinus deep, variable in width; basal sinus shallow, narrow; lateral sinus a notch; teeth deep, wide. Flowers self-fertile, open in mid-season; stamens upright.

Fruit late, keeps well. Clusters large, long, broad, tapering, usually single-shouldered, usually two bunches per shoot; pedicel long, thick, smooth; brush green with yellow tinge. Berries large, round-oval, purplish-black, dull with heavy bloom, persistent, firm; skin tough, free; flesh green, translucent, juicy, tender, vinous; good. Seeds free, one to six, large, long, notched, brown.

Hopkins

(Rotundifolia)

Hopkins is named by grape-growers in the South Atlantic states as the best early Rotundifolia grape. Its season in North Carolina begins early in August, nearly a month before any other. It is, also, one of the best in quality and for quality and earliness should be in every home vineyard in the region in which it grows. Hopkins was found near Wilmington, North Carolina, about 1845, by John Hopkins.

Vine very vigorous, hardy, productive. Canes long, slender, upright. Leaves of medium size, variable, cordate, longer than broad, thick, leathery, smooth, dark green; margins sharply serrate. Flowers self-fertile.

Fruit very early. Clusters large, containing from four to ten berries. Berries large, dark purple or almost black, round-oblong, shelling badly; skin thick, tough, faintly marked with dots; pulp white, tender, juicy with a sweet, pleasant flavor; one of the best of the Rotundifolias in quality.

Hosford

(Labrusca)

Hosford is an offspring of Concord, differing from the parent chiefly in the greater size of bunch and berry and in being less fruitful. The variety is surpassed by Worden and Eaton, of the same type, and is probably not worth cultivation. It is claimed by some that Hosford is identical with Eaton but there are noticeable differences in both vine and fruit characters. The vine looks very like that of Concord except that the indentations along the margins of the leaves are deeper. Hosford originated in the garden of George Hosford, Ionia, Michigan, about 1876, as a chance seedling growing between two Concord vines.

Vines lacking in vigor, hardy, unproductive. Canes short, few in number, slender; nodes enlarged; internodes very short; tendrils continuous, bifid or trifid. Leaves medium in size; upper surface light green, rugose; lower surface grayish-white to bronze, heavily pubescent; lobes faint; petiolar sinus wide; teeth small, sharp. Flowers shallow, semi-fertile, open in mid-season; stamens upright.

Fruit mid-season, does not keep well. Clusters large, tapering, slightly shouldered, compact; pedicel short with small warts; brush slender, green. Berries large, round-oval, dull black with abundant bloom, persistent; skin thick, tender; flesh pale green, juicy, fine-grained, tender, vinous, sweet; good. Seeds few, large, broad, blunt, plump, brown.

Hybrid Franc

(Vinifera, Rupestris)

Hybrid Franc is the best-known cross between Rupestris and Vinifera. It is one of the few varieties used in Europe as a resistant stock now recommended for a direct producer. The vines are hardy, vigorous and very productive. The fruit is fit only for wine or grape-juice, being too acid to eat out of hand. The coloring matter in the fruit is very intense and

might be used in giving color to grape products. The variety is of French origin.

Vine vigorous, hardy, productive. Canes numerous, thick, light brown with blue bloom; nodes enlarged; internodes short; tendrils intermittent, long, bifid or trifid. Leaves small, thin; upper surface light green, glossy, smooth; lower surface green, hairy along ribs and large veins; lobes three to five with terminal one acute; petiolar sinus narrow, sometimes closed and overlapping; lateral sinus a notch. Flowers semi-fertile, open early; stamens upright.

Fruit mid-season, does not keep well. Clusters medium in size, short, cylindrical, single-shouldered, compact; pedicel long, slender with few small warts; brush short, wine-colored. Berries small, oblate, black, glossy with thick bloom, persistent, firm; skin thin, tender with very dark wine-colored pigment; flesh green with reddish tinge, translucent, juicy, fine-grained, tender, spicy, tart; fair in quality. Seeds free, one to five, small, short, light brown.

Ideal

(Labrusca, Vinifera, Bourquiniana)

Ideal is a handsome seedling of Delaware, from which it differs chiefly in being larger in bunch and berry, attaining in both of these characters nearly the size of Catawba. In Kansas and Missouri, this variety is highly recommended, not only for the high quality of the fruit, ranking with Delaware in quality, but because of vigorous, healthy, productive vines. But farther north the vines are precariously hardy and not sufficiently fruitful, healthy nor vigorous to warrant high recommendation. Ideal originated with John Burr, Leavenworth, Kansas, from seed of Delaware, about 1885.

Vine vigorous, doubtfully hardy, productive; tendrils intermittent, bifid or trifid. Canes long, numerous, slender, dark brown; nodes enlarged, flattened; internodes long. Leaves large, variable in color; lobes three to five; petiolar sinus deep, wide; teeth deep, narrow; upper surface light green, dull; lower surface pale green, pubescent.

Fruit early mid-season, keeps well. Clusters large, broad, heavily shouldered; pedicel thick; brush green. Berries large, round, dark

red with thin bloom, usually persistent, firm; skin thick, tough, adherent; flesh green, tender, aromatic, sweet next the skin, acid at the center; good to very good. Seeds adherent, large, plump, brown.

Iona

(Labrusca, Vinifera)

In flavor, the fruit of Iona (Plate XIX) has a rare combination of sweetness and acidity, pure, delicate and vinous. The flesh is transparent, melting, tender, juicy and of uniform consistency quite to the center. The seeds are few and small and part readily from the flesh. The color is a peculiar dark-red wine with a tint of amethyst, variable and not always attractive. The bunch is large but loose, with berries varying in size and ripening unevenly. The fruit may be kept until late winter. The vine characters of Iona are not as good as those of the fruit. To do well, the vine must have a soil exactly suited to its wants, seemingly thriving best in deep, dry, sandy or gravelly clays. Iona responds especially well when trained against walls or buildings, attaining under such conditions rare perfection. The vines are doubtfully hardy and in many parts of the North must have winter protection; they are not vigorous and are inclined to overbear, to remedy which they must have close pruning. In localities in which mildew and rot thrive, the variety is badly attacked by these diseases. Iona originated with C. W. Grant, Iona Island, New York, from seed of Diana planted in 1885.

Vine weak, doubtfully hardy, unproductive. Canes short, light brown; nodes enlarged; internodes short; tendrils intermittent, bifid. Leaves thick; upper surface light green, dull, smooth; lower surface grayish-green, heavily pubescent; lobes three to five with terminal one acute; petiolar sinus of medium depth and width; basal sinus shallow; lateral sinus shallow, wide; teeth shallow. Flowers self-fertile, open late; stamens upright.

Fruit late, keeps well. Clusters medium in size, sometimes double-shouldered, slender, tapering, loose; brush pale green. Berries uni-

PLATE XXIX. — Vergennes ($\times \frac{2}{3}$).

form, oval, round, dull, light and dark red with thin bloom, persistent, firm; skin tough, adherent, slightly astringent; flesh green, translucent, juicy, fine-grained, tender, melting, vinous; very good. Seeds free, one to four, small, broad, plump, brown.

Isabella

(Labrusca, Vinifera)

Alexander, Black Cape, Christie's Improved Isabella, Concckling's Wilding, Constantia, Dorchester, Gibb's Grape, Hensell's Long Island, Payne's Early, Helene, Woodward

Isabella (Plate XX) is now of little more than historical interest, it having been one of the mainstays of American viticulture. In appearance, the fruit of Isabella is fully as attractive as that of any black grape, the clusters being large and well formed and the berries glossy black with thick bloom. The flavor is good, but the thick skin and muskiness in taste are objectionable. The grapes keep and ship well. Isabella is surpassed in vine characters by many other kinds, notably Concord, which has taken its place. The lustrous green, ample foliage which remains late in the season, and the vigor of the vine, make this variety an attractive ornamental, well adapted for growing on arbors, porches and trellises. The origin of Isabella is not known. It was obtained by William Prince, Flushing, Long Island, about 1816 from Mrs. Isabella Gibbs, Brooklyn, New York.

Vine vigorous, hardy, productive. Canes short, numerous with heavy pubescence, thick, light brown; nodes enlarged, flattened; internodes short; tendrils continuous, long, bifid or trifid. Leaves thick; upper surface dark green, smooth, glossy; lower surface whitish-green, heavily pubescent; lobes three when present with terminal lobe obtuse; petiolar sinus shallow, narrow, often closed, overlapping; basal sinus usually wanting; lateral sinus shallow, narrow, frequently notched; teeth shallow, wide. Flowers self-fertile, open in mid-season; stamens upright.

Fruit late, keeps and ships well. Clusters large, cylindrical, frequently single-shouldered; pedicel slender, smooth; brush long,

yellowish-green. Berries medium to large, oval, black with heavy bloom, persistent, soft; skin thick, tough, adherent, astringent; flesh pale green, translucent, juicy, fine-grained, tender, meaty, some foxiness, sweet; good. Seeds one to three, large, broad, distinctly notched, short, brown with yellow tips.

Isabella Seedling

(Labrusca, Vinifera)

Isabella Seedling is an early, vigorous, productive offspring of Isabella. In fruit characters it greatly resembles its parent, but ripens its crop earlier and has a more compact bunch. Like that of its parent, the fruit is of good quality and keeps remarkably well. This seedling is now grown more than Isabella and, while not of any considerable commercial importance, is far more deserving attention as a market grape than some of the poorly flavored kinds more generally grown. There are several varieties under this name. Two are mentioned by Warder; one of Ohio and one of New York origin. The Isabella Seedling here described originated with G. A. Ensenberger, Bloomington, Illinois, in 1889.

Vine vigorous, healthy, hardy, productive. Canes long, thick, dark brown, often with a red tinge, with thin bloom; nodes prominent, flattened; internodes long; tendrils intermittent or continuous, bifid. Leaves healthy, large, thick; upper surface green, dull; lower surface pale green or grayish-green, occasionally with a tinge of bronze, pubescent. Flowers self-fertile; stamens upright.

Fruit early, keeps well. Clusters large, long, slender, cylindrical, usually single-shouldered, loose, compact. Berries large, oval, often pear-shaped, dull black with thick bloom, persistent, soft; skin thick with some red pigment; flesh pale green, juicy, tender, coarse, vinous; good. Seeds numerous, free, large, broad, notched, dark brown.

Israella

(Labrusca, Vinifera)

Israella came from C. W. Grant contemporaneously with Iona and was heralded as the earliest good grape in cultivation.

For several years after its introduction, it was widely tried but was almost everywhere discarded because of the poor quality and unattractive appearance of the fruit and lack of vigor, hardiness and productiveness in the vine. Grant grew Israella from seed of Isabella planted in 1885.

Vine lacking in vigor, unproductive. Canes slender, dark brown; nodes enlarged, flattened; internodes short; tendrils continuous, bifid. Leaves large; upper surface light green, dull, rugose; lower surface pale green, pubescent; lobes one to five, faint; petiolar sinus deep, narrow; teeth shallow, sharp; stamens upright.

Fruit late, keeps well. Clusters large, of medium length and breadth, tapering, often single-shouldered, compact, frequently with many abortive fruits. Berries of medium size, round-oval, black or purplish-black with thin bloom, inclined to drop, soft; skin thick, tough with a large amount of purplish-red pigment; flesh pale green, juicy, stringy, mild, sweet from skin to center; fair in quality. Seeds free, medium in size, notched, blunt, light brown, often covered with grayish warts.

Ives

(Labrusca, Æstivalis)

Ives' Madeira, Ives' Seedling, Kittredge

Ives has a high reputation as a grape for making red wine, being surpassed only by Norton for this purpose. The vine is hardy, healthy, vigorous and fruitful. The fruit is poor in quality, colors long before ripe, has a foxy odor, and the flesh is tough and pulpy. The bunches are compact, with well-formed, jet-black grapes, which make them attractive. The vine is easily propagated and is adapted to any good grape soil, but is so rampant in growth that it is difficult to manage. The variety is not widely cultivated. Ives was grown by Henry Ives from seed planted in 1840 in his garden in Cincinnati, Ohio.

Vine vigorous, hardy, healthy, productive. Canes long, thick, reddish-brown with thin bloom; nodes enlarged, flattened; internodes short; tendrils continuous, bifid or trifid. Leaves large; upper

surface dark green, dull, rugose; lower surface pale green, pubescent; lobes three to five when present with terminal one acute; petiolar sinus deep, narrow, sometimes closed and overlapping; basal sinus shallow; lateral sinus narrow; teeth shallow.

Fruit late mid-season, keeps well. Clusters large, tapering, frequently single-shouldered, compact, often with numerous abortive berries; pedicel slender with numerous small warts; brush short, slender, pale with a reddish-brown tinge. Berries oval, jet-black with heavy bloom, very persistent, firm; skin tough, adherent, wine-colored pigment, astringent; flesh pale green, translucent, juicy, fine-grained, tough, foxy; good. Seeds adherent, one to four, small, often abortive, broad, short, blunt, plump, brown.

James

(Rotundifolia)

James is one of the largest of the Rotundifolia grapes and probably the best general-purpose variety of this species. The vine is noted for vigor and productiveness. It cannot be grown north of Maryland. It thrives in sandy loam soils with clay subsoil. The variety was found by B. W. M. James, Pitt County, North Carolina. It was introduced about 1890 and was placed on the grape list of the American Pomological Society fruit catalog in 1899.

Vine vigorous, healthy, productive. Canes slender, numerous, long, slightly trailing. Leaves of medium size, thick, smooth, leathery, cordate, as broad as long, with a serrate margin. Flowers open late; stamens reflexed.

Fruit ripens late, hangs on the vine for three weeks, keeps well. Clusters small, containing from four to twelve berries, irregular, loose. Berries large, three-fourths to one and one-fourth inches in diameter, round, blue-black, marked with specks; skin thick, tough. Pulp juicy, sweet; good in quality.

Janesville

(Labrusca, Vulpina)

Endowed with a constitution enabling it to withstand cold to which most other grapes succumb, Janesville has made a

place for itself in far northern localities. Moreover, the grapes ripen early, being about the first to color although they are not ripe until some time after coloring. The vine also is healthy, vigorous and productive. The fruit, however, is worthless when better sorts can be grown. The clusters and berries are small, the grapes are pulpy, tough, seedy, have a thick skin and a disagreeable acid taste. Janesville was grown by F. W. Loudon, Janesville, Wisconsin, from chance seed planted in 1858.

Vine vigorous, hardy, healthy, productive. Canes spiny, numerous, dark brown; nodes flattened; internodes long; tendrils intermittent or continuous, long, bifid or trifid. Leaves small, thin; upper surface glossy, smooth; lower surface pale green, lightly pubescent; leaf usually not lobed with terminus acute; petiolar sinus narrow, often closed and overlapping; basal and lateral sinuses lacking; teeth shallow. Flowers self-fertile, open very early; stamens upright.

Fruit early, keeps well. Clusters small, short, cylindrical, usually single-shouldered, compact; pedicel short, slender, covered with small, scattering warts; brush dark wine color. Berries round, dull black with heavy bloom, persistent, firm; skin thick, tough, adherent with dark wine-colored pigment, astringent; flesh pale reddish-green, translucent, juicy, tough, coarse, vinous, acid; fair in quality. Seeds adherent, one to six, large, broad, angular, blunt, dark brown.

Jefferson

(Labrusca, Vinifera)

Jefferson (Plate XXI) is an offspring of Concord crossed with Iona, and resembles Concord in vigor, productiveness and healthiness of vine, and Iona in color and quality of fruit. The vine produces its fruit two weeks later than Concord and is not as hardy, faults that debar it from taking high rank as a commercial grape. Fortunately the vines yield readily to laying down for winter protection so that even in commercial plantations it is not difficult to prevent winter injury. The bunches of Jefferson are large, well-formed, compact with berries of uniform size and color. The flesh is firm yet tender, juicy with a rich, vinous flavor and a delicate aroma which persists even after the ber-

ries have dried into raisins. The fruit ships and keeps well, the berries adhering to the cluster and the fruit retaining its freshness into late winter. Jefferson is widely distributed and is well known by viticulturists in eastern America. It is not particular as to localities, if the season be long and the climate temperate, and thrives in all soils. The variety originated with J. H. Ricketts, Newburgh, New York; it fruited first in 1874.

Vine vigorous, healthy, doubtfully hardy, productive. Canes short, numerous, light to dark brown; nodes enlarged, round; internodes short; tendrils intermittent, short, bifid or trifid. Leaves healthy; upper surface light green, older leaves rugose; lower surface pale green, strongly pubescent; leaf usually not lobed with terminus acute; petiolar sinus narrow, sometimes closed and overlapping; basal sinus usually absent; lateral sinus shallow, often a mere notch; teeth regular, shallow. Flowers self-fertile, open late; stamens upright.

Fruit late, keeps and ships well. Clusters large, cylindrical, usually single-shouldered, sometimes double-shouldered, compact; pedicel short, slender with a few inconspicuous warts; brush long, slender, pale yellowish-green. Berries medium in size, oval, light and dark red, glossy with thin bloom, persistent, very firm; skin thick, tough, free, slightly astringent; flesh light green, translucent, juicy, coarse-grained, tender, vinous; good to best. Seeds free, one to four, broad, short, blunt, plump, brown.

Jessica

(Labrusca, Vinifera)

Jessica is an early, hardy, green grape. The fruit is sweet, rich, sprightly and almost free from foxiness, but is unattractive and does not keep well. The clusters and berries are small, and the clusters are too loose for a good grape. Jessica may be commended for earliness and hardiness and is, therefore, desirable, if at all, in northern regions. William H. Read, Port Dalhousie, Ontario, grew Jessica from seed planted some time between 1870 and 1880.

Vine medium in vigor, healthy, hardy, productive. Canes long, thick, dark brown with red tinge; nodes enlarged, flattened; inter-

nodes short; tendrils continuous or intermittent, bifid or trifid. Leaves small; upper surface dark green, glossy, often rugose; lower surface pale green, very pubescent; lobes three; petiolar sinus narrow; teeth shallow, narrow. Flowers self-fertile, open in mid-season; stamens upright.

Fruit very early. Clusters small, slender, tapering, usually single-shouldered. Berries small, round, light green, often tinged with yellow, covered with thin bloom, persistent, soft; skin thin, adherent, faintly astringent; flesh pale green, transparent, juicy, tender, soft, sprightly, sweet; good. Seeds adherent, medium to broad, notched, brown.

Jewel

(Labrusca, Bourquiniana, Vinifera)

The notable characters of Jewel are earliness and high quality in fruit; although, as compared with Delaware, its parent, the vine is vigorous, healthy and hardy. In form and size of bunch and berry, Jewel closely resembles Delaware, but the grapes are deep black in color. The flesh characters and flavor of the fruit are much like those of Delaware, the pulp being tender yet firm, and the flavor having the same rich, sprightly, vinous taste found in the parent. The seeds are few and small. The skin is thin but tough, and the grapes ship well, keep long, do not shell, and although early, hang until frost. Jewel is a most excellent grape, worthy the place among black grapes that Delaware has among red varieties. In particular, it is recommended for earliness and for localities in the North where standard varieties do not ripen. John Burr, Leavenworth, Kansas, grew Jewel from seed of Delaware planted about 1874.

Vine vigorous, healthy, hardy, productive. Canes slender, light reddish-brown; nodes enlarged, flattened; internodes short; tendrils continuous, bifid. Leaves scant, thick; upper surface light green, dull, rugose; lower surface tinged with bronze, heavily pubescent; lobes three when present with terminus acute; petiolar sinus narrow; basal sinus usually lacking; lateral sinus shallow, wide; teeth shallow. Flowers self-sterile, open in mid-season; stamens reflexed.

Fruit early. Clusters small, slender, cylindrical, single-shouldered, compact; pedicel short, slender; brush short, wine-colored. Berries

medium in size, round, dark purplish-black, dull with heavy bloom, persistent, firm; skin thin, tough, adherent, wine-colored pigment; flesh pale green, translucent, juicy, fine-grained, tender, sprightly, vinous, sweet; very good. Seeds adherent, one to four, frequently one-sided, blunt, light brown.

KENSINGTON

(Vinifera, Vulpina)

Kensington has several very meritorious fruit and vine characters. The vine resembles that of Clinton, its Vulpina parent, in vigor, hardiness, growth and productiveness, but the fruit has many of the characters of the European parent, Buckland Sweetwater. The grapes are yellowish-green, large, oval and borne in loose clusters of medium size. In quality the fruit of Kensington is not equal to that of Buckland Sweetwater but is much better than that of Clinton. The flesh is tender and juicy with a rich, sweet, vinous flavor. The hardiness of the vine and the high quality of the fruit should make Kensington a favorite green grape in northern gardens. This variety was grown by William Saunders, London, Ontario. It was sent out some time between 1870 and 1880.

Vine vigorous, hardy, productive. Canes long, slender, light brown; nodes enlarged, flattened; internodes short; tendrils persistent, intermittent or continuous, long, bifid or trifid. Leaves thin; upper surface light green, glossy, smooth; lower surface pale green, pubescent, hairy; lobes wanting or one to three with terminus obtuse; petiolar sinus narrow; basal sinus shallow when present; lateral sinus shallow, usually a notch; teeth deep and wide. Flowers self-fertile, open early, stamens upright.

Fruit mid-season. Clusters large, cylindrical, often heavily single-shouldered, loose, frequently with many undeveloped berries; pedicel long and slender with small, inconspicuous warts; brush short, pale green. Berries variable in size, oval, yellowish-green, glossy with thin bloom, persistent, firm; skin thin, tough, adherent, faintly astringent; flesh green, transparent, juicy, tender, vinous, sweet; good. Seeds free, two to four, wrinkled, large, long, broad, sharp-pointed, yellowish-brown.

King

(Labrusca)

King is similar to Concord, compared with which the vine is more vigorous and prolific, time of ripening and length of season the same, the clusters are one-fourth larger, the grapes are more persistent, the pulp is more tender, the flavor nearly the same but more sprightly, the seeds fewer in number, the wood harder and of shorter joints and the pedicels larger. King was found in the Concord vineyard of W. K. Munson, Grand Rapids, Michigan, in 1892. The vine was set for Concord and is supposed to be a bud-sport of that variety.

Vine very vigorous, hardy, productive. Canes large, dark reddish-brown; nodes enlarged, slightly flattened; internodes short; tendrils continuous or intermittent, trifid or bifid. Leaves unusually large, thick; upper surface green, dull; lower surface grayish-white changing to slight bronze, pubescent; lobes three when present, terminal one acute; teeth shallow, narrow. Flowers self-fertile, open in mid-season; stamens upright.

Fruit mid-season, keeps well. Clusters large, long, broad, irregularly tapering, usually single-shouldered, compact. Berries large, round, black with thin bloom, persistent, firm; skin thick, tough, adherent, astringent; flesh pale green, very juicy, tough, stringy and with some foxiness; good. Seeds adherent, few, large, short, broad, lightly notched if at all, blunt, plump, light brown.

Lady

(Labrusca, Vinifera)

The vine of Lady is much like that of Concord, its parent, although not quite so vigorous nor productive, but ripens its fruit fully two weeks earlier. The fruit is much superior to that of Concord in quality, being richer, sweeter and less foxy. The grapes hang on the vines well but deteriorate rapidly after picking. The term, "ironclad," used by grape-growers to express hardiness and freedom from disease, is probably as applicable to Lady as to any other of the Labrusca grapes.

The foliage is dense and of a deep glossy green, neither scalding under a hot sun nor freezing until heavy frosts, making it an attractive ornament in the garden. Lady is deservedly popular as a grape for the amateur and should be planted for nearby markets. It succeeds wherever Concord is grown, and because of its early ripening is especially adapted to northern latitudes where Concord does not always mature. Although the fruit ripens early, the buds start late, often escaping late spring frosts. When Lady was first heard of, it was in the hands of a Mr. Imlay, Muskingum County, Ohio. George W. Campbell, Delaware, Ohio, introduced it in 1874.

Vine vigorous, hardy, medium in productiveness, healthy. Canes short, slender, dark reddish-brown; nodes flattened; internodes short; tendrils intermittent, bifid or trifid. Leaves medium in size; upper surface light green, glossy, rugose; lower surface pale green, pubescent; lobes one to five with terminal one acuminate; petiolar sinus shallow, wide; lateral sinus variable in depth and width; teeth shallow. Flowers self-fertile, open in mid-season; stamens upright.

Fruit early, does not keep well. Clusters small, short, slender, cylindrical, sometimes single-shouldered, compact; pedicel thick, smooth; brush slender, long, greenish-white. Berries large, round, light green, often with a tinge of yellow, glossy with thin bloom, persistent, firm; skin covered with small, scattering, dark dots, thin, tender, adherent, astringent; flesh greenish-white, translucent, juicy, tender, aromatic; very good. Seeds free, few, broad, light brown.

Lady Washington

(Labrusca, Vinifera)

Lady Washington is in many respects a most excellent grape but falls short in quality and does not excel in vine characters. The grapes make a good appearance, keep and ship well and are tender, juicy and sweet. The vines are luxuriant, hardy, for a grape with Vinifera blood, and healthy although slightly susceptible to mildew. As an exhibition grape, few green varieties show better when grown with care than Lady Washington. In the West and Southwest, the variety is said

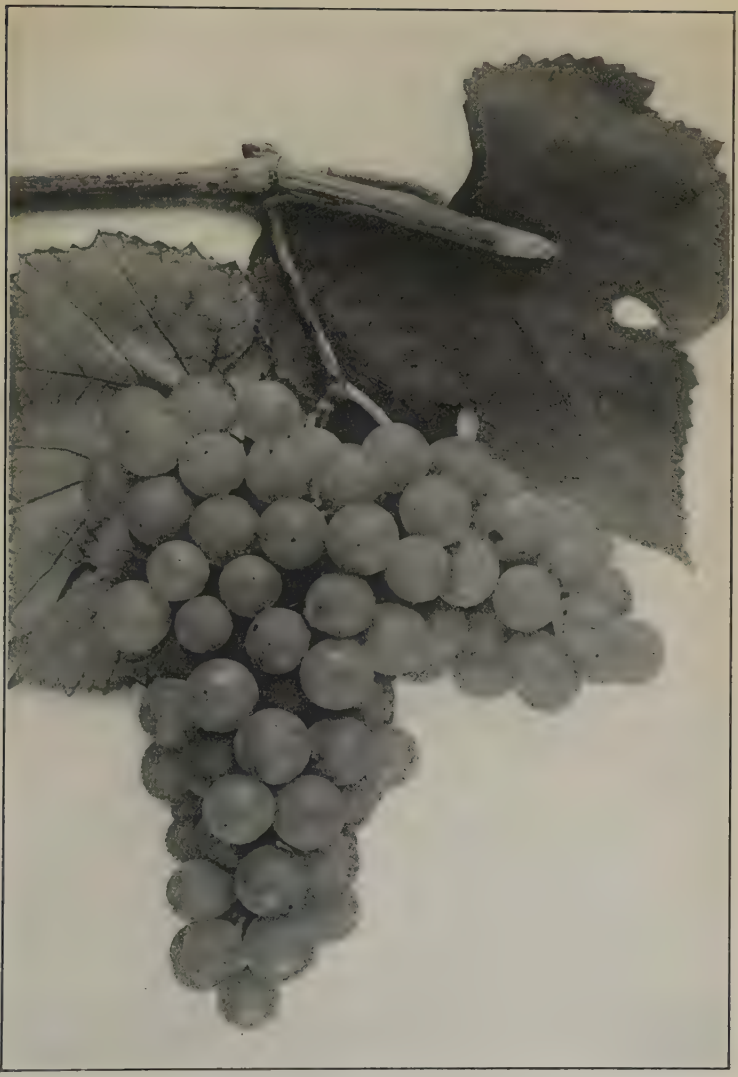

PLATE XXX. — Winchell ($\times\frac{2}{3}$).

to succeed better than any other Concord seedling. Lady Washington is another of J. H. Ricketts' fine seedlings, this variety having come from seed of Concord fertilized by Allen's Hybrid. It was introduced in 1878.

Vine vigorous, productive. Canes long, few, thick, dark brown; nodes greatly enlarged, variable in shape; internodes long; tendrils continuous, long, bifid or trifid. Leaves large, thick; upper surface dark green, older leaves strongly rugose, glossy; lower surface pale green, pubescent; leaf entire with terminal acute; petiolar sinus deep, narrow, frequently closed and overlapping; basal sinus usually wanting; lateral sinus shallow; teeth shallow, narrow. Flowers self-fertile, open in mid-season; stamens upright.

Fruit late mid-season, keeps and ships well. Clusters large, broad, irregularly cylindrical, single-shouldered, frequently double-shouldered, loose; pedicel short with numerous conspicuous warts; brush very short, greenish. Berries variable in size, round-oblate, yellow-amber, glossy with thin bloom, persistent; skin thin, tender, adherent; flesh pale green, transparent, juicy and tender, stringy, aromatic, sweet; very good. Seeds free, one to four, broad, brown.

Lenoir

(Bourquiniana)

Alabama, Black El Paso, Black July, Black Spanish, Blue French, Burgundy, Cigar Box Grape, Devereaux, Jack, Jacques, July Sherry, Longworth's Ohio, MacCandless, Ohio, Springstein, Warren

Lenoir is a tender southern grape which has been used largely in France and California as a resistant stock and a direct producer. The fruit is highly valued for its dark red wine and is very good for table use. The vine is very resistant to phylloxera and withstands drouth well. The origin of Lenoir is unknown. It was in cultivation in the South as long ago as the early part of the last century. Nicholas Herbemont states in 1829 that its name was given from a man named Lenoir who cultivated it near Stateburg, South Carolina.

Vine vigorous, thrifty, semi-hardy, productive. Canes numerous, with some bloom at the nodes; tendrils intermittent. Leaves from two to seven-lobed, usually five, with characteristic bluish-green color above and pale green below.

Clusters variable, medium to very large, tapering, usually shouldered. Berries small, round, dark bluish-purple, nearly black with lilac bloom; skin thick, tough; flesh juicy, tender, sweet, very rich in coloring matter.

Lignan Blanc

(Vinifera)

White July, Luglienga, Joannenc

At Geneva, New York, Lignan Blanc ripens first of all grapes, native or European. It is not of highest quality but is better than any other early grape and makes a valuable addition to the home vineyard. It is a favorite grape in Europe and is rather commonly grown in California. This variety offers excellent material for hybridization with native grapes.

Vine vigorous, medium productive; buds open early; opening leaves light green, glossy, tinged with red along the edges, thinly pubescent. Leaves medium in size, roundish, somewhat dull green, slightly rugose; lower surface glabrous; blade thick; lobes usually five though sometimes three; petiolar sinus medium in depth, wide; lower lateral sinus medium in depth, narrow; upper lateral sinus shallow, narrow; margin dentate; teeth long, narrow. Flowers appear early for a Vinifera; stamens upright.

Fruit ripens the first of September and is a good keeper; clusters above medium in size, tapering, medium compact; berries medium to large, oval, yellowish-green, with thin bloom; skin thin, tender, neutral; flesh greenish-white, firm, juicy, meaty, sweet; quality good.

Lindley

(Labrusca, Vinifera)

By common consent, Lindley (Plate XXII) is the best of the red grapes originated by Rogers in his crosses between Labrusca and Vinifera. The bunches are of only medium size and

are loose, but the berries are well-formed, of uniform size and an attractive dark red color. The flesh is firm, fine-grained, juicy, tender with a peculiarly rich aromatic flavor. The skin is thick and tough but is not objectionable in fruit fully ripe. The fruit keeps and ships well, and the berries neither crack nor shatter. The vine is vigorous, hardy for a Vinifera hybrid, healthy but, as with most of its kind, susceptible to mildew. The chief defects of Lindley are self-sterility, precariousness in bearing and lack of adaptation to many soils. Lindley is a general favorite in the garden. In 1869 Rogers gave this grape its name in honor of John Lindley, the English botanist.

Vine vigorous, usually hardy, susceptible to mildew. Canes very long, dark reddish-brown with thin bloom; nodes enlarged, usually flattened; internodes long, thick; tendrils continuous, long, bifid or trifid. Leaves large, thick; upper surface light green, dull, slightly rugose; lower surface grayish-white, pubescent; obscurely three-lobed with terminus acute; petiolar sinus deep, narrow, often closed and overlapping; teeth shallow. Flowers self-sterile, open in mid-season; stamens reflexed.

Fruit mid-season, keeps and ships well. Clusters long, broad, cylindrical, frequently single-shouldered, the shoulder being connected to the bunch by a long stem, loose; pedicel short, slender, smooth; brush short, pale green. Berries large, round-oval, dark-red with faint bloom; skin tough, adherent, unpigmented, strongly astringent; flesh pale green, translucent, juicy, fine-grained, tender, vinous; good to best. Seeds adherent, two to five, notched, brown.

Lucile

(Labrusca)

In vigor, health, hardiness and productiveness, Lucile (Plate XXII) is not surpassed by any native grape. Unfortunately, the fruit characters are not so desirable. The size, form and color of bunches and berries are good, making a very attractive fruit, but the grapes have an obnoxious, foxy taste and odor and are pulpy and seedy. Lucile is earlier than Concord, the crop

ripening with that of Worden or preceding it a few days. For an early variety, the fruit keeps well and in spite of thin skin ships well. The vine thrives in all grape soils. Lucile may be recommended where a hardy grape is desired and for localities in which the season is short. J. A. Putnam, Fredonia, New York, grew Lucile. The vine fruited first in 1890. It is a seedling of Wyoming, which it resembles in fruit and vine and surpasses in both.

Vine vigorous, hardy, very productive. Canes long, light brown; nodes enlarged, flattened; internodes short; tendrils continuous, bifid or trifid. Leaves large, firm; upper surface light green, glossy, smooth; lower surface pale green, pubescent; leaf with terminus acute; petiolar sinus shallow, narrow, sometimes closed and overlapping; basal sinus usually absent; lateral sinus a notch when present; teeth shallow. Flowers self-fertile, open early; stamens upright.

Fruit early, keeps well. Clusters large, long, slender, cylindrical, usually single-shouldered, very compact; pedicel short, thick with few, small, inconspicuous warts; brush light brown. Berries large, round, dark red with thin bloom, persistent, firm; skin thin, tender, astringent; flesh pale green, translucent, juicy, tough, stringy, foxy; fair in quality. Seeds adherent, one to four, small, broad, short, blunt, dark brown.

Lutie

(Labrusca)

Lutie (Plate XXIII) is chiefly valuable for its vine characters. The vines are vigorous, hardy, healthy and fruitful, although scarcely equaling Lucile in any of these characters. Pomologists differ widely as to the merits of the fruit, some claiming high quality for it and others declaring that it is no better than a wild Labrusca. The difference of opinion is due to a peculiarity of the fruit; if eaten fresh, the quality, while far from being of the best, is not bad, but after being picked for several days it develops so much foxiness of flavor and aroma that it is scarcely edible. Lutie is a seedling found by L. C. Chisholm, Spring Hill, Tennessee. It was introduced in 1885.

Vine vigorous, hardy, healthy, productive. Canes short, slender, dark reddish-brown; nodes enlarged; internodes short; tendrils continuous, short, bifid. Leaves medium in size; upper surface dark green, rugose; lower surface bronze or whitish-green, pubescent; leaf usually not lobed with terminus acute; petiolar sinus deep, wide; basal sinus lacking; lateral sinus shallow and narrow when present; teeth shallow, narrow. Flowers self-fertile, early; stamens upright.

Fruit early, does not keep well. Clusters medium in size, short, broad, blunt, cylindrical, usually not shouldered, compact; pedicel short with small, scattering warts; brush slender, pale green. Berries large, round, dark red, dull with thin bloom, drop badly from pedicel, firm; skin tender, adherent, astringent; flesh pale green, translucent, juicy, tough, foxy; fair in quality. Seeds adherent, one to four, large, broad, short and blunt, dark brown.

Malaga

(Vinifera)

Malaga is one of the favorite table-grapes in California and also a popular grape to ship to eastern markets. In some parts of southern California, where the Muscats do not thrive, it is much grown, and in the San Joaquin Valley it is rather largely used in making raisins. It requires a long season and probably could not be grown in eastern regions except in the most favored localities. The description is compiled.

Vine very vigorous, healthy and productive; wood reddish-brown, short-jointed. Leaves of medium size, smooth, leathery; light glossy green above, lighter below; deeply lobed. Bunches very large, long, loose, shouldered, sometimes scraggly; stem long and flexible; berries very large, oval, yellowish-green, covered with light bloom; skin thick; flesh firm, crisp, sweet and rich; quality good. Season late, keeps and ships well.

McPike

(Labrusca)

McPike is noteworthy because of the large size of the berries and bunches. It is very similar to its parent, Worden, differ-

ing in having fewer but larger berries, grapes not as high in flavor and fewer and smaller seeds. Because of the thin, tender skin, the berries crack badly. The grapes shell more or less, and the vines are less productive than those of Worden. The faults named debar it from becoming a commercial grape and it is not high enough in quality to make it of value for the amateur. This variety originated with H. G. McPike, Alton, Illinois, from seed of Worden planted in 1890.

Vine vigorous, hardy, very productive. Canes of medium length, dull reddish-brown; nodes enlarged, flattened; internodes very short; tendrils continuous, bifid or trifid. Leaves large, thick; upper surface light green, dull, rugose; lower surface grayish-white, heavily pubescent; leaf entire with terminus acute; petiolar sinus deep; basal and lateral sinuses lacking. Flowers nearly self-fertile.

Fruit mid-season, keeps well. Clusters variable in size, broad, irregularly tapering, usually not shouldered; pedicel long, thick, smooth; brush long, slender, green with brown tinge. Berries unusually large, round, purplish-black with heavy bloom, firm; skin cracks, adherent to pulp, astringent; flesh pale green, translucent, juicy, tender, stringy, vinous; fair to good. Seeds adherent, one to four, short, broad, blunt, plump, light brown.

Marion

(Vulpina, Labrusca)

Black German, Marion Port

Marion so closely resembles Clinton in botanical and horticultural characters as to be clearly of the same type. The vine is vigorous and hardy, but hardly sufficiently productive, and is susceptible to mildew and leaf-hoppers. The fruit is pleasantly sweet and spicy, although not high enough in quality for a table-grape, but makes a very good dark red wine. The fruit colors early but ripens late, hangs well on the vines and improves with a touch of frost. Marion was brought to notice by a Mr. Shepherd, Marion, Ohio, about 1850.

Vine vigorous, hardy, productive. Canes very long, dark reddish-brown, covered with bloom; nodes enlarged, flattened; internodes very long; tendrils continuous, sometimes intermittent, long, bifid. Leaves very large; upper surface dark green, glossy; lower surface pale green, smooth; leaf entire, terminus acuminate; petiolar sinus very deep, narrow, often closed and overlapping; basal and lateral sinuses usually lacking; teeth shallow, wide. Flowers self-sterile, open very early; stamens reflexed.

Fruit mid-season, keeps well. Clusters medium in size, short, slender, cylindrical, single-shouldered, compact; pedicel short, slender with a few inconspicuous warts; brush very short, wine-colored. Berries small, round, black, glossy with heavy bloom, persistent, firm; skin thin, tough, adherent with much wine-colored pigment, astringent; flesh dark green, translucent, juicy, fine-grained, tough, sprightly, spicy, tart; fair in quality. Seeds adherent, one to five, medium in size, broad, short, very plump, brown.

Martha

(Labrusca, Vinifera)

Martha was at one time a popular green grape, but the introduction of superior varieties has reduced its popularity until now it is but little grown. It is a seedling of Concord and resembles its parent, differing chiefly as follows: fruit green, a week earlier, bunch and berry smaller, flavor far better, being sweeter, more delicate and less foxy. The vine of Martha is a lighter shade of green, is less robust, and the blossoms open a few days earlier than those of Concord. One of the defects of Martha, and the chief cause of its going out of favor, is that it does not keep nor ship well. The variety is still being planted in the South but is generally abandoned in the North. Samuel Miller, Calmdale, Pennsylvania, grew Martha from seed of Concord; it was introduced about 1868.

Vine hardy, productive, susceptible to attacks of mildew. Canes long, dark reddish-brown, surface with thin bloom, roughened; nodes enlarged, slightly flattened; tendrils continuous, or intermittent, bifid. Leaves large, thick; upper surface light green; lower surface light

bronze, heavily pubescent; lobes wanting or faint; petiolar sinus shallow, very wide; teeth irregular. Flowers self-fertile, open in mid-season; stamens upright.

Fruit early mid-season. Clusters medium in size, tapering, single-shouldered, loose; pedicel short, slender; brush very short, green. Berries medium in size, round, light green with thin bloom, persistent; skin thin, very tender, adherent; flesh pale green, juicy, tough, fine-grained, slightly foxy; very good. Seeds few in number, adherent, broad, blunt, dark brown.

Massasoit

(Labrusca, Vinifera)

Massasoit is distinguished as the earliest of Rogers' hybrids, ripening with Delaware. The grapes have the peculiarity of being best before full maturity, developing, after ripening, a degree of foxiness which impairs the quality. In shape and size of berry and bunch, there is a striking resemblance to Isabella, but the color is that of Catawba. The texture of the fruit is especially good, firm but tender and juicy, while the flavor is rich and sweet. The vine is vigorous, hardy and productive but subject to mildew and rot. Massasoit is worth a place in the home vineyard and as an early grape of fine quality for local markets.

Vine very vigorous, hardy, very productive, subject to rot and mildew. Canes long, thick, dark brown with reddish tinge; nodes enlarged, flattened; tendrils continuous, long, trifid or bifid. Leaves variable in size; upper surface light green, dull, smooth; lower surface pale green, pubescent; lobes three to five with terminus acute; petiolar sinus deep, narrow; basal sinus shallow, narrow, obscure; teeth shallow. Flowers self-sterile, open late; stamens reflexed.

Fruit early, keeps well. Clusters variable in size, broad, cylindrical, frequently single-shouldered; pedicel slender with a few indistinct warts; brush pale green. Berries large, round-oval, dark brownish-red, dull with thin bloom, very persistent, firm; skin thin, tender, adherent, astringent; flesh pale green, translucent, juicy, fine-grained, soft, stringy, foxy; good to very good. Seeds adherent, one to five, large, broad, distinctly notched, plump, blunt.

Maxatawney

(Labrusca, Vinifera)

While at one time very popular, grape-growers now seldom hear of Maxatawney. It is a southern grape, ripening its fruit in the North only occasionally. The variety is interesting historically as being the first good green grape and as showing unmistakable Vinifera characters, another example of the fortuitous hybridization which gave so many valuable varieties before artificial hybridization of Vinifera with native grapes had been tried. In 1843, a man living in Eagleville, Pennsylvania, received several bunches of grapes from Maxatawney. The seeds of these grapes were planted and one grew, the resulting plant being the original vine of Maxatawney.

Vine vigorous, doubtfully hardy, variable in productiveness. Canes medium in length, slender, reddish; nodes enlarged, flattened; internodes short; tendrils continuous, bifid. Leaves large, dark green, thick; lower surface grayish-white with tinge of bronze, heavily pubescent; lobes three to five; petiolar sinus narrow; teeth shallow. Flowers self-sterile, open in mid-season; stamens upright.

Fruit late, keeps well. Clusters small to medium, short, slender, cylindrical, occasionally with a small, single shoulder, compact; pedicel long, slender, warty; brush long, yellow. Berries variable in size, oval, pale red or dull green with amber tinge, with thin bloom, persistent; skin tough, astringent; flesh tender, foxy; good to very good. Seeds free, few, large, very broad, blunt.

Memory

(Rotundifolia)

Memory is one of the best of the Rotundifolia grapes for the garden and local markets, its fruits being especially good for dessert. As yet, however, the variety has not been widely distributed even in North Carolina where it originated. The vine is given credit for being the most vigorous grower and the most productive of the grapes of its species. Memory is probably a seedling of Thomas, which it much resembles,

having been found in a vineyard of Thomas grapes near Whiteville, North Carolina, by T. S. Memory, about 1868.

Vine very vigorous, healthy, productive. Leaves large, longer than broad, thick, smooth with coarsely serrate margins. Flowers perfect.

Fruit ripens in September in North Carolina; clusters large, with from four to twelve berries which hang unusually well for a variety of V. Rotundifolia. Berries very large, round-oblong, deep brownish-black, almost jet black; skin thick; flesh tender, juicy, sweet; good to best.

Merrimac

(Labrusca, Vinifera)

Merrimac is often accredited as the best black grape among Rogers' hybrids, but an analysis of the characters of the several black varieties grown by Rogers shows that it is surpassed by Wilder, Herbert and possibly Barry. The vine is strong in growth, productive, hardy and exempt from fungal diseases; but the grapes are not high in quality, and flesh, skin and seed characters are such that the fruit is not as pleasant to eat as the other black varieties named. Merrimac is worthy a place in collections for the sake of variety. Rogers gave this variety the name Merrimac in 1869.

Vine vigorous, usually hardy, productive. Canes slender, dark brown, surface roughened; nodes enlarged, flattened; internodes short; tendrils intermittent, short, bifid. Leaves large, thin; upper surface very light green, glossy, smooth; lower surface pale green, pubescent and cobwebby; lobes three with terminal one obtuse; petiolar sinus deep, narrow, sometimes closed and overlapping; basal sinus usually lacking; lateral sinus shallow, narrow; teeth shallow. Flowers self-sterile, open in mid-season; stamens reflexed.

Fruit mid-season, keeps and ships well. Clusters variable in size, broad, tapering; pedicel slender, covered with numerous inconspicuous warts; brush wine-colored. Berries large, round, black, glossy with abundant bloom, persistent, firm; skin thick, tough, adherent, astringent; flesh light green, translucent, juicy, fine-grained, tender, stringy; good. Seeds adherent, one to five, broad, long, with enlarged neck, brown.

Mills

(Labrusca, Vinifera)

The bunches and berries of Mills are large and well-formed; the berries are firm and solid, with the skin adherent as in Viniferas; the flesh is juicy and parts readily from the seeds; the flavor is rich, sweet and vinous; and the grapes are hardly surpassed in keeping quality. But when the fruit characters of Mills have been praised, nothing further can be said in its favor. The vines are neither vigorous, hardy nor fruitful and are very subject to mildew; neither wood nor roots ripen well in the North in average seasons; and the variety is a most difficult one for nurserymen to grow. Mills is of doubtful commercial value, but for the garden it is possible that the grower may be able to graft it to advantage on some variety with better vine characters. William H. Mills, Hamilton, Ontario, grew Mills about 1870 from seed of Muscat Hamburg fertilized by Creveling.

Vine medium in vigor, hardiness and productiveness. Canes long, thick, light brown; nodes enlarged, flattened; tendrils intermittent, bifid or trifid. Leaves large, thick; upper surface dark green, dull, rugose; lower surface pale green, cobwebby; lobes three to five with terminus acute; petiolar sinus intermediate in depth and width; basal and lateral sinuses deep and wide; teeth deep. Flowers self-fertile, open in mid-season; stamens upright.

Fruit mid-season, keeps well. Clusters large, long, slender, cylindrical, often double-shouldered, compact; pedicel slender with numerous, small warts; brush long, wine-colored. Berries large, oval, jet-black with abundant bloom, persistent, firm; skin thick, tough, adherent; flesh light green, translucent, juicy, rich, tender, sprightly, vinous, sweet; very good to best. Seeds free, one to three, large, brown.

Mish

(Rotundifolia)

Mish is a favorite Rotundifolia in North Carolina, being planted extensively in some parts of that state. Its outstand-

ing characters are vigor and productiveness in vine and high quality in the fruit. Mish is named by many as the best all-round Rotundifolia, being of value for dessert, wine and grape-juice. The variety was found by W. M. Mish, about 1846, near Washington, North Carolina.

Vine very vigorous, productive, healthy, open in growth; canes somewhat trailing. Leaves large, round, thick, smooth, leathery with coarsely dentate margin. Flowers perfect.

Fruit late, does not ripen uniformly, keeps and ships well. Clusters of medium size with from six to fifteen berries which cling well to the pedicel. Berries of medium size, round-oval, deep reddish-black with numerous conspicuous dots; skin thin, cracking in wet weather; flesh tender, juicy, sweet, exceptionally well flavored; very good to best.

Mission

(Vinifera)

Of all grapes, Mission has probably played the most important part in the vineyards of California. Grown from the earliest times at the old missions, its source or its name has never been determined. Its viticultural value for table and wine-press was early appreciated by California grape-growers, and its culture rapidly spread to every county in the state adapted to grape-growing. With vines vigorous, healthy and productive, bearing grapes of delicious quality, Mission is a mainstay on the Pacific slope, surpassed by few vineyard varieties for general usefulness. The description is compiled.

Vine vigorous, healthy, productive; wood short-jointed, grayish-brown, dull, dark. Leaf medium to large, slightly oblong, with large, deeply-cut compound teeth; basal sinus widely opened, primary sinuses narrow and shallow; smooth on both sides with scattered tomentum below, bright green above, lighter below. Bunch divided into many small, distinct lateral clusters, shouldered, loose, sometimes very loose; berries of medium size, purple or almost black with heavy bloom; skin thin; flesh firm, crisp, juicy, sweet, rich and delicious. Seeds rather large and prominent; season late.

Missouri Riesling

(Vulpina, Labrusca)

Missouri Riesling attains perfection only in the South. The vines are hardy, vigorous, productive and healthy in the North, as a rule, but the fruit is lacking in quality. In the South, Missouri Riesling is a beautiful fruit when well grown and has many good qualities of fruit and vine. It originated with Nicholas Grein, Hermann, Missouri, about 1870, probably from seed of Taylor.

Vine vigorous, hardy, productive. Canes very long, numerous, thick, dark brown; nodes enlarged; internodes long; tendrils continuous, long, trifid or bifid. Leaves large, thick; upper surface dark green, glossy, smooth; lower surface pale green, thinly pubescent; lobes five with terminal one acuminate; petiolar sinus deep, narrow; basal sinus shallow, wide; lateral sinus deep, wide; teeth deep, wide. Flowers self-fertile, open in mid-season; stamens upright.

Fruit late, does not keep nor ship well. Clusters short, cylindrical, single-shouldered; pedicel long with few small warts; brush green. Berries of medium size, round, yellowish-green changing to light red with thin bloom, persistent, firm; skin sprinkled with small brown dots, thin, tough, adherent, astringent; flesh pale green, translucent, juicy, tender, fine-grained, lacking in aroma, mild; fair in quality. Seeds adherent, one to four, surface rough, dark brown.

Montefiore

(Vulpina, Labrusca)

Montefiore is extensively grown in Missouri and the Southwest but is almost unknown in the North and East. It is reported as succeeding in the Lake District of Ohio and, with the exception that it is uncertain in bearing and not always productive, it grows well in sections of New York. While it is essentially a wine-grape, yet it is pleasing in taste and texture of fruit and is far better in quality than many of the coarser Labruscas commonly cultivated. It keeps and ships well

and presents an attractive appearance. Jacob Rommel, Morrison, Missouri, grew this variety about 1875 from seed of Taylor fertilized by Ives.

Vine vigorous and hardy. Canes long, thick, dark brown with thin bloom; nodes enlarged, flattened; internodes long; tendrils continuous, long, bifid. Leaves thick; upper surface light green, dull, smooth; lower surface grayish-white, pubescent; lobes three when present with terminus acute; petiolar sinus wide; basal sinus lacking; lateral sinus shallow when present; teeth deep. Flowers semi-fertile, open in mid-season; stamens upright.

Fruit mid-season, keeps well. Clusters small, short, tapering, single-shouldered, the shoulder being connected to the bunch by a long stem, compact; pedicel short, slender, smooth; brush red. Berries small, oval, often compressed, black, glossy with abundant bloom, persistent, firm; skin thin, tough, adherent, astringent; flesh green, translucent, juicy, fine-grained, tender, melting, vinous, sweet; fair to good. Seeds free, one to five, small, broad, faintly notched, short, plump, brown.

Moore Early

(Labrusca)

Moore Early (Plate XXIV) is the standard grape of its season. Its fruit cannot be described better than as an early Concord. The vines are readily distinguishable from those of Concord, differing chiefly in being less productive. To grow the variety satisfactorily, the soil must be rich, well-drained and loose, must be frequently cultivated, and the vines should be pruned severely. The bunches of Moore Early are not as large as those of Concord and are less compact; the berries shell rather more easily, and the skin cracks more readily. The flesh characters and the flavor are essentially those of Concord, although the quality is not as high as in the older variety. The quality is, however, much higher than that of Champion and Hartford, its chief competitors, and varieties which it should replace. Moore Early is by no means an ideal grape for its season, but until something better is introduced it will probably remain the best early commercial sort. Captain

John B. Moore, Concord, Massachusetts, originated this variety from seed of Concord, planted about 1868.

Vine vigorous, hardy, unproductive. Canes short, dark reddish-brown; nodes enlarged, flattened; internodes short; tendrils continuous, bifid or trifid. Leaves large, thick; upper surface dark green, dull; lower surface tinged with bronze, heavily pubescent; leaf usually not lobed, terminus acute; petiolar sinus wide; basal sinus lacking; lateral sinus a notch when present; teeth shallow, narrow. Flowers fertile, open in mid-season; stamens upright.

Fruit early, does not keep well. Clusters medium in size, length, and breadth, cylindrical, sometimes single-shouldered, loose; pedicel short, thick, smooth; brush short, pale green. Berries large, round, purplish-black, firm; skin tender, adherent; flesh green, translucent, juicy, fine-grained, tough with slight foxiness; fair to good. Seeds one to four, large, broad, plump, blunt, brown with yellow tinge at tips.

Moscatello

(Vinifera)

Moscatello Nero. Black Muscat

Beautiful in appearance and having a delicate Muscat taste and aroma, this variety is one of the good table-grapes of the Pacific slope. Unfortunately it ripens so late that it is hardly worth trying in the East. The variety has the reputation of being very productive. The description is compiled.

Vine vigorous, healthy, very productive. Leaves of medium size, with deep upper and shallow lower sinuses; glabrous above, slightly downy below, very hairy on the veins, with long, sharp teeth. Bunch large to very large, long, loose, conico-cylindrical, winged; berries very large, borne on long slender pedicels, dark purple, almost black; skin thin but tough; flesh rather soft, juicy; flavor sweet, rich, aromatic, musky; quality very good. Season late, does not keep well.

Moyer

(Labrusca, Bourquiniana)

Jordan, Moyer's Early Red

Moyer is almost a counterpart of its parent, Delaware. Were it not that the variety is from one to two weeks earlier

than Delaware, and somewhat hardier, hence better adapted for cold regions, it could have no place in viticulture. Compared with Delaware, the vine is hardly as vigorous and is less productive, but is freer from rot and mildew. The bunches are much like those of Delaware but have the fault of setting fruit imperfectly even when cross-pollination is assured; the berries are a little larger, of much the same color and of like flavor, rich, sweet, with pure vinousness and without a trace of foxiness. The fruit keeps well, ships well and does not crack nor shell. Moyer is well established in Canada, proving perfectly hardy wherever Concord is grown, possibly standing even more cold. W. H. Read, Port Dalhousie, Ontario, raised the original vine of Moyer, about 1880, from seed of Delaware fertilized by Miller's Burgundy.

Vine vigorous, hardy, healthy, unproductive. Canes numerous, slender, dull, dark reddish-brown; nodes enlarged, flattened; internodes short; tendrils continuous, long, bifid or trifid. Leaves small; upper surface dark green, dull, smooth; lower surface pale green or with faint blue tinge, heavily pubescent; lobes two to five with terminus acute; petiolar sinus shallow; basal sinus shallow when present; lateral sinus shallow, narrow; teeth very shallow, narrow. Flowers self-sterile, open early; stamens reflexed.

Fruit early, keeps well but loses color if kept too long. Clusters small, short, slender, tapering, sometimes single-shouldered; pedicel short with small warts; brush yellowish-green. Berries small, oblate, dark red with faint bloom, persistent, firm; skin tough, free, astringent; flesh translucent, juicy, tender, fine-grained, vinous; good to very good. Seeds free, one to four, broad, short, very blunt, brown with yellow tinge at tips.

Muscatel

(Vinifera)

White Frontignan

This old and standard sort is rather commonly grown in some of the grape regions of California to follow Chasselas

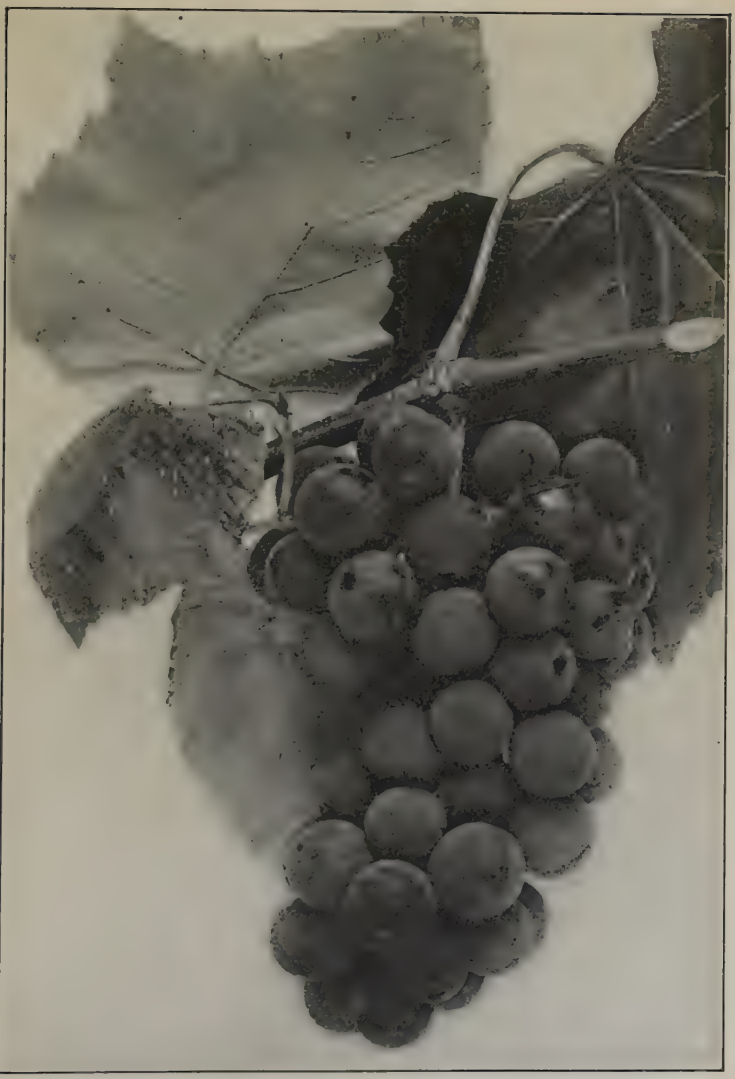

PLATE XXXI. — Worden ($\times \frac{2}{3}$).

Golden. It might be tried with some show of success in favored grape regions in the East. The description is compiled.

Vine of medium size, vigorous, healthy; canes strong, spreading, reddish-brown with short internodes. Leaves of medium size, thin, five-lobed; glabrous except on the lower sides of the well-marked ribs where a few hairs show. Bunches long, cylindrical, regular, compact; berries round, golden-yellow becoming amber; flavor sweet, rich, aromatic, peculiar; quality very good. Season late mid-season, keeps and ships well.

Muscat Hamburg

(Vinifera)

Muscat Hamburg (Plate XXV) is an old European grape well known in some parts of America in greenhouse graperies, since it is one of the best for forcing. All who know the beautiful fruits of this variety grown in forcing-houses will want to test it out of doors, where at the Geneva, New York, Experiment Station, they have done well, many clusters attaining a weight of a pound and a half to two pounds. The accompanying plate, the fruit much less than half natural size, shows what a fine grape Muscat Hamburg is. One is struck with wondering admiration at a vine laden with these grapes growing alongside Concord, Niagara or Delaware. The quality is delectable, the quintessence of the flavors and aromas which make the grape a favorite fruit. The grapes keep long and retain their form, size, color and rich, delicate flavor almost to the end. This variety is a treasure to the amateur; and the professional who wants another grape for local markets should try grafting over a few vines of some native to this sort, following the directions given in Chapter X in caring for the vines.

Vines vigorous, tender, need protection during the winter; canes long, numerous, slender to medium, light brown, darker at the nodes which are enlarged and flattened. Leaves medium to large, intermediate in thickness; upper surface light green, dull; lower surface pale green, faintly pubescent, densely hairy.

Fruit ripens in October, ships and keeps well; clusters very large, long, broad, tapering, single or double-shouldered. Berries large, firm, oval, very dark purplish-red, covered with lilac bloom, very persistent; skin thick, adheres strongly to the pulp; flesh pale green, translucent, meaty, very juicy, tender, vinous, musky, sweet, rich; very good to best; seeds separating easily from the pulp, large.

Muscat of Alexandria

This is possibly the leading table- and raisin-grape of the Pacific slope. From the literature or from a visit to vineyards, one cannot make out whether one or several varieties are grown under the name. Probably there are several strains grown under the distinctive name "Muscat" which applies to these sweet, light yellow, musky grapes. This is one of the standard sorts to force indoors but requires too long a season for out of doors in the East. The following description is compiled:

Vine short, straggling, bushy, sometimes forming a bush rather than a vine, very productive; wood gray with dark spots, short-jointed. Leaf round, five-lobed; bright green above, lighter green below. Bunches long and loose, shouldered; berry oblong, light yellow and transparent when fully mature, covered with white bloom; flesh firm, crisp; flavor sweet and very musky; quality good. Season late, the laterals producing a second and sometimes even a third crop.

Niagara

(Labrusca, Vinifera)

Niagara (Plate XXVI) is the leading American green grape, holding the rank among grapes of this color that Concord maintains among black varieties. It is, however, a less valuable grape than Concord, and it is doubtful whether it should be ranked much higher than several other green grapes. In vigor and productiveness, when the two grapes are on equal footing as to adaptability, Niagara and Concord rank the same. In hardiness of root and vine, Niagara falls short of Concord; it cannot

be relied on without winter protection where the thermometer falls below zero. Niagara has much of the foxiness of the wild Labrusca, distasteful to many palates. Both bunches and berries of Niagara are larger than those of Concord and are better formed, making a handsomer fruit if the colors are liked equally well. The fruit shells as badly as that of Concord and does not keep longer. Both vine and fruit of Niagara are more susceptible to fungal diseases than those of Concord, especially to black-rot, which proves a veritable scourge with this variety in unfavorable seasons. Niagara was produced by C. L. Hoag and B. W. Clark, Lockport, New York, from seed of Concord fertilized by Cassady planted in 1868.

Vine vigorous, lacking in hardiness, very productive. Canes long, thick, reddish-brown deepening in color at the nodes which are enlarged and slightly flattened; internodes long, thick; tendrils continuous, long, bifid or trifid. Leaves large, thick; upper surface glossy, dark green, smooth; lower surface pale green, pubescent; lobes three to five with terminus acute; petiolar sinus of medium depth and width; basal sinus shallow, wide, often toothed; lateral sinus wide, frequently toothed; teeth shallow, variable in width. Flowers self-fertile, open in mid-season; stamens upright.

Fruit mid-season, keeps well. Clusters large, long, broad, tapering, frequently single-shouldered, compact; pedicel thick with a few, small, inconspicuous warts; brush pale green, long. Berries large, oval, pale yellowish-green with thin bloom, persistent, firm; skin thin, tender, adherent, astringent; flesh light green, translucent, juicy, fine-grained, tender, foxy; good. Seeds free, one to six, deeply notched, brown.

Noah

(Vulpina, Labrusca)

Noah is little grown at present outside of Missouri, where it is still planted somewhat. Noah and Elvira are often confused but there are very marked differences. The clusters of Elvira are smaller, the berries are more foxy in taste, and the skins are more tender and crack more readily than do those of Noah. The large, dark, glossy green leaves make the vines of

this variety very handsome. As with Elvira and other varieties of this group, Noah is of little value in the North. It originated with Otto Wasserzieher, Nauvoo, Illinois, from seed of Taylor planted in 1869.

Vine vigorous, doubtfully hardy, productive. Canes long, thick, dark brown, surface roughened; nodes enlarged, flattened; tendrils continuous, bifid or trifid. Leaves large; upper surface dark green, glossy, smooth; lower surface pale green, thinly pubescent; leaf usually not lobed with terminus acuminate; petiolar sinus deep, wide; basal sinus lacking; lateral sinus very shallow when present; teeth shallow, wide. Flowers semi-fertile, open early; stamens upright.

Fruit late mid-season, does not ship nor keep well. Clusters variable in size, cylindrical, single-shouldered, compact; pedicel short with a few small warts; brush short, brown. Berries small, round, light green tinged with yellow, dull with thin bloom, firm; skin adherent to pulp; flesh yellowish-green, translucent, juicy, tough, fine-grained, vinous, sprightly; good. Seeds adherent, one to four, dark brown.

Northern Muscadine

(Labrusca)

That this variety, together with Lucile, Lutie and other grapes with the foxy taste strongly marked, has not become popular, in spite of good vine characters, is evidence that the American public do not desire such grapes. In appearance of fruit, Northern Muscadine is much like Lutie, the two being distinguished from other grapes by an unmistakable odor. A serious defect of the fruit is that the berries shatter badly as soon as they reach maturity. Taken as a whole, the vine characters of this variety are very good and offer possibilities for the grape-breeder. The variety originated at New Lebanon, New York, and was brought to notice by D. J. Hawkins and Philemon Stewart of the Society of Shakers about 1852.

Vine vigorous, productive, healthy, hardy. Canes slender, dark brown, heavily pubescent; tendrils continuous, bifid, dehisce early. Leaves large, round, thick; upper surface dull, rugose; lower surface

dark bronze, heavily pubescent. Flowers self-fertile, open in mid-season; stamens upright.

Fruit early mid-season, does not keep well. Clusters medium in size, short, occasionally single-shouldered, compact. Berries large, oval, dark amber with thin bloom, drop badly from the pedicel; skin tough, adherent, astringent; flesh pale green, juicy, fine-grained, tender, soft, very foxy, sweet; poor in quality. Seeds free, numerous, large, broad, faintly notched, long, brown.

Norton

(Æstivalis, Labrusca)

Norton is one of the leading wine-grapes in eastern America, the fruit having small value for any other purpose than wine or, possibly, grape-juice. The vine is hardy but requires a long, warm season to reach maturity so that it is seldom grown successfully north of the Potomac. Norton thrives in rich alluvial clays, gravels or sands, the only requisite seemingly being a fair amount of fertility and soil warmth. The vines are robust; very productive, especially on fertile soils; as free, or more so, from fungal diseases as any other of our native grapes; and are very resistant to phylloxera. The bunches are of but medium size and the berries are small. The grapes are pleasant eating when fully ripe, rich, spicy and pure-flavored but tart if not quite ripe. The variety is difficult to propagate from cuttings and to transplant, and the vines do not bear grafts well. The origin of Norton is uncertain, but it has been under cultivation since before 1830, when it was first described.

Vine very vigorous, healthy, half-hardy, productive. Canes long, thick, dark brown with abundant bloom; nodes much enlarged; internodes long; tendrils intermittent, occasionally continuous, long, bifid, sometimes trifid. Leaves large, irregularly round; upper surface pale green, dull, rugose; lower surface pale green, pubescent; leaf usually not lobed with terminus acute; petiolar sinus deep, narrow, sometimes closed and overlapping; basal sinus usually absent; lateral sinus shallow or a mere notch when present. Flowers self-fertile, late; stamens upright.

Fruit late, keeps well. Clusters medium in size, short, broad, tapering, single-shouldered, compact; pedicel slender with a few warts; brush dull, wine-colored. Berries small, round-oblate, black, glossy with heavy bloom, persistent, soft; skin thin, free with much dark red pigment; flesh green, translucent, juicy, tender, spicy, tart. Seeds free, two to six, small, brown.

Oporto

(Vulpina, Labrusca)

Oporto was at one time in demand as a wine grape because its wine resembled in color and flavor that from Oporto. The variety is now scarcely known, being inferior in most of its horticultural characters to others of its species, but might be valuable in breeding for some of its characters. The vine is very hardy, unusually free from fungal diseases, is very resistant to phylloxera and has been used in France as a phylloxera-resistant grafting-stock. The juice is very thick and dark, a deep purple, hence suitable for adding color to wine or grape-juice. The origin of Oporto is unknown. It was brought into cultivation about 1860 by E. W. Sylvester, Lyons, New York.

Vine very vigorous, hardy, healthy, variable in productiveness. Canes long, reddish-brown; nodes enlarged, flattened; internodes long, diaphragm thin; tendrils continuous, bifid. Stamens reflexed.

Fruit mid-season, ships and keeps well. Clusters small, cylindrical, often single-shouldered. Berries medium in size, round, black, glossy with abundant bloom, persistent, firm; skin very thin, tender, with much dark wine-colored pigment; flesh white, sometimes with purple tinge, juicy, fine-grained, solid, sweet, spicy; fair quality. Seeds free, numerous, small, broad, faintly notched, sharply pointed, plump, dark brown.

Othello

(Vinifera, Vulpina, Labrusca)

Arnold's Hybrid, Canadian Hamburg, Canadian Hybrid

In France, Othello does remarkably well as a direct producer and is used also for a resistant stock. While most of its

characters are spoken of in the superlative by the French, in America the variety is not so highly esteemed because of susceptibility to fungi. Moreover, the fruit matures so late that it could never become a valuable variety for the North. It is in no sense a table-grape but makes a well-colored, pleasant wine. Charles Arnold, Paris, Ontario, grew Othello from seed of Clinton fertilized by Black Hamburg and planted in 1859.

Vine vigorous, hardy, productive. Canes long, brown; nodes enlarged, flattened; tendrils continuous, sometimes intermittent, bifid or trifid. Leaves of average size; upper surface light green, dull and smooth; lower surface pale green, pubescent; lobes three to five with terminal lobe acute; petiolar sinus deep, very narrow, frequently closed and overlapping; basal sinus shallow, narrow; lateral sinus deep; teeth deep, wide; stamens upright.

Fruit late, keeps fairly well. Clusters large, long, broad, tapering, frequently with a loose single shoulder, compact; pedicel long, slender with numerous small warts; brush short, wine-colored. Berries large, oval, black, glossy with abundant bloom, very persistent; skin thin, tough, adherent with red pigment; flesh dark green, very juicy, fine-grained, tough, sprightly; low in quality. Seeds free, one to three, neck sometimes swollen, brown.

Ozark

(Æstivalis, Labrusca)

Ozark belongs to the South and to Missouri in particular. Its merits and demerits have been threshed out by the Missouri grape-growers with the result that its culture is somewhat increasing. It is a grape of low quality, partly, perhaps, from overbearing, which it habitually does unless the fruit is thinned. The vine is healthy and a very strong grower, but is self-sterile, which is against it as a market sort. In spite of self-sterility and low quality, Ozark is a promising variety for the country south of Pennsylvania. Ozark originated with J. Stayman, Leavenworth, Kansas, from seed of unknown source. The variety was introduced about 1890.

Vine very vigorous, hardy, productive. Canes long, thick with thin bloom, surface roughened; nodes enlarged, flattened; internodes long; tendrils intermittent, usually bifid. Leaves dense, large; upper surface light green; lower surface pale green, thinly pubescent, cobwebby; lobes three to five; petiolar sinus deep, narrow; serrations shallow, narrow. Flowers self-sterile or nearly so, open late; stamens reflexed.

Fruit late, keeps well. Clusters large, long, usually with a long, loose shoulder, very compact; pedicel short, thick, smooth; brush long, red. Berries variable in size, dull black with abundant bloom, persistent; skin tough with much wine-colored pigment; flesh tender, mild; fair in quality. Seeds free, small.

Palomino

(Vinifera)

Golden Chasselas. Listan

This variety seems to be grown in California under the three names given — while in France Palomino is described as a bluish-black grape. Palomino seems to be grown commonly in California as a table-grape and is worth trying in eastern America. The variety received under the name Palomino from California at the New York Experiment Station has the following characters, agreeing closely with those set down by Californian viticulturists:

Fruit ripens about the 20th of October, keeping qualities good; clusters medium to large, long, single-shouldered, tapering, loose; berries medium to small, roundish, pale greenish-yellow, thin bloom; skin and the adhering flesh medium tender and crisp, flesh surrounding seeds melting; flavor sweet, vinous; quality good.

Peabody

(Vulpina, Labrusca, Vinifera)

Peabody is as yet a comparatively unimportant offspring of Clinton. The grapes are of excellent quality. It appears to do better in the northern tier of states or in Canada, than

farther south. This variety was grown by J. H. Ricketts about 1870.

Vine vigorous, hardy, productive. Canes long, numerous, thick, light brown with ash-gray tinge, darker at nodes, covered with thin bloom; nodes enlarged, flattened; internodes short; tendrils intermittent, bifid or trifid. Leaves medium in size; upper surface dark green, thin; lower surface pale green, nearly glabrous; lobes three, acuminate; petiolar sinus shallow, wide; serration deep, narrow. Flowers semi-fertile, mid-season; stamens upright.

Fruit early, keeps well. Clusters large, long, usually with a shoulder connected to the bunch by a long stem, compact; pedicel short, slender, warty; brush short, green. Berries oval, black, glossy, covered with thin bloom, persistent; skin thick, tough; flesh very juicy, tender, vinous, spicy, agreeably sweet at the skin, tart at the center; good. Seeds free, broad.

Perfection

(Labrusca, Bourquiniana, Vinifera)

Perfection is a seedling of Delaware, which it greatly resembles but does not equal in fruit; its fruits being hardly as high in quality, do not keep as well, shrivel more before ripening, and shell more readily. In its vine characters, it is much more like a Labrusca than Delaware, suggesting that it is a Delaware cross. In the Southwest, Perfection is considered a valuable early red grape. J. Stayman, Leavenworth, Kansas, grew Perfection from seed of Delaware; it was sent out for testing about 1890.

Vine vigorous, healthy, injured in severe winters, productive. Canes of medium length and number, slender; nodes enlarged, flattened; internodes short; tendrils intermittent, trifid or bifid. Leaves healthy, medium in size; upper surface light green; lower surface grayish-white with a tinge of bronze, heavily pubescent; lobes wanting or three to five; petiolar sinus shallow, wide; serration shallow. Flowers self-fertile or nearly so, open in mid-season; stamens upright.

Fruit early. Clusters usually single-shouldered, compact; pedicel short, slender, smooth; brush short, yellow. Berries small, round, red but less brilliant than Delaware with faint bloom, inclined to drop from pedicel, soft; skin thin, free from astringency; flesh medium in

juiciness and tenderness, vinous, mild, sweet; good in quality. Seeds adherent, numerous, small, often with an enlarged neck.

Perkins

(Labrusca, Vinifera)

At one time Perkins was grown largely as an early grape but has been discarded very generally on account of the poor quality of the fruit. The pulp of the grape is hard and the flavor is that of Wyoming and Northern Muscadine, grapes characterized by disagreeable foxiness. As with nearly all Labruscas, Perkins is a poor keeper. Notwithstanding the faults of its fruit, the variety may have value in regions where grape-growing is precarious; for in fruiting it is one of the most reliable grapes cultivated, the vines being hardy, vigorous, productive and free from fungal diseases. Perkins is an accidental seedling found about 1830 in the garden of Jacob Perkins, Bridgewater, Massachusetts.

Vine vigorous, hardy, healthy, productive. Canes long, numerous, thick, dark brown, deepening in color at the nodes, surface heavily pubescent; nodes enlarged, flattened; internodes long; tendrils continuous, bifid or trifid. Leaves medium in size, thick; upper surface rugose; lower surface heavily pubescent; veins distinct; lobes three; petiolar sinus deep, narrow; serration shallow. Flowers self-fertile, early; stamens upright.

Fruit early, ships well. Clusters of medium size and length, broad, cylindrical, often with a single shoulder, compact; pedicel short, thick, warty; brush long, yellow. Berries large, oval, pale lilac or light red with thin bloom, inclined to drop from the pedicel, soft; skin thin, tough, without pigment; flesh white, juicy, stringy, fine-grained, firm, meaty, very foxy; poor in quality. Seeds adherent, numerous, medium in size, notched.

Pocklington

(Labrusca)

Before the advent of Niagara, Pocklington (Plate XXII) was the leading green grape. The variety has the fatal fault, how-

ever, of ripening its crop late, which with some minor defects has caused it to fall below Niagara for northern grape districts. Pocklington is a seedling of Concord and resembles its parent in vine characters; the vines are fully equal to or surpass those of Concord in hardiness, but are of slower growth and not quite as healthy, vigorous nor productive. In quality, the grapes are as good if not better than those of Concord or Niagara, being sweet, rich and pleasantly flavored, although as with the other grapes named, it has too much foxiness for critical consumers. Pocklington is not equal to several other grapes of its season in quality, as Iona, Jefferson, Diana, Dutchess and Catawba, but it is far above the average and for this reason should be retained. John Pocklington, Sandy Hill, New York, grew Pocklington from seed of Concord about 1870.

Vine medium in vigor, hardy. Canes of medium length, number and size, dark reddish-brown; nodes enlarged, flattened; tendrils continuous, bifid or trifid. Leaves variable in size, thick; upper surface light green, glossy; lower surface tinged with bronze, pubescent; lobes one to three with terminus acuminate; petiolar sinus deep, wide; teeth narrow. Flowers self-fertile, mid-season; stamens upright.

Fruit late mid-season, keeps and ships well. Clusters large, cylindrical, often single-shouldered, compact; pedicel short, thick with a few small warts; brush short, green. Berries large, oblate, yellowish-green with tinge of amber, with thin bloom, firm; skin with scattering russet dots, thin, tender, adherent, faintly astringent; flesh light green with yellow tinge, translucent, juicy, tough, fine-grained, slightly foxy; good. Seeds adherent, one to six, of medium length and breadth.

Poughkeepsie

(Bourquiniana, Labrusca, Vinifera)

Poughkeepsie has been known long on the Hudson River, yet it is now little grown there and has not been disseminated widely elsewhere. In quality of fruit, it is equal to the best American varieties, but the vine characters are all poor and the variety is thus effectually debarred from common cultivation. Both vine and fruit resemble those of Delaware, but in

neither does it quite equal the latter. In particular, the vine is more easily winter-killed and is less productive than that of Delaware. The grapes ripen a little earlier than those of the last named sort and this, with their beauty and fine quality, is sufficient to recommend it for the garden at least. About 1865, A. J. Caywood, Marlboro, New York, grew Poughkeepsie from seed of Iona fertilized by mixed pollen of Delaware and Walter.

Vine of medium vigor. Canes short, thick, dark reddish-brown; tendrils intermittent, frequently three in line, bifid or trifid. Leaves small; upper surface green, glossy, older leaves rugose; lower surface grayish-green, pubescent. Flowers self-fertile, late; stamens upright. Fruit early, keeps and ships well. Clusters small, tapering, usually single-shouldered, very compact. Berries small, round, pale red with thin bloom, persistent, firm; skin thin, tender, without pigment; flesh pale green, very juicy, tender, melting, fine-grained, vinous, sweet; very good to best. Seeds free, small, broad, with enlarged neck, brown.

Prentiss

(Labrusca, Vinifera)

Prentiss is a green grape of high quality, once well known and generally recommended, but now going out of cultivation because the vine is tender to cold, lacks in vigor, is unproductive, uncertain in bearing and is subject to rot and mildew. There are vineyards in which it does very well and in such it is a remarkably attractive green grape, especially in form of cluster and in color of berry, in these respects resembling the one-time favorite, Rebecca, although not so high in quality as that variety. Its season is given as both before and after Concord. Prentiss always must remain a variety for the amateur and for special localities. It originated with J. W. Prentiss, Pulteney, New York, about 1870 from seed of Isabella.

Vine weak. Canes thick, light to dark brown; tendrils continuous, bifid. Leaves small, thick; upper surface light green, rugose in the

older leaves; lower surface pale green, pubescent. Flowers self-fertile, mid-season; stamens upright.

Fruit variable in season, about with Concord, keeps well. Cluster medium in size, tapering, sometimes with a single shoulder, compact. Berries medium in size, oval, light green with a yellow tinge, thin bloom, persistent, firm; skin tough, without pigment; flesh pale green, juicy, foxy; good. Seeds adherent, numerous, notched, short, sharp-pointed, dark brown.

Purple Cornichon

(Vinifera)

Black Cornichon

By virtue of attractive appearance and excellent shipping qualities of the fruit, this variety takes high place among the commercial grapes of California. Late ripening is another quality making it desirable, while its curious, long, curved berries add novelty to its attractions. The fruit does not take high rank in quality. The description has been compiled.

Vine very vigorous, healthy and productive; wood light brown striped with darker brown, short-jointed. Leaves large, longer than wide, deeply five-lobed; dark green above, lighter and very hairy below; coarsely toothed; with short, thick petiole. Bunches very large, loose or sometimes scraggly, borne on long peduncles; berries large, long, more or less curved, dark purple, spotted, thick-skinned, borne on long pedicels; flesh firm, crisp, sweet but not rich in flavor; quality good but not high. Season late, keeps and ships well.

Rebecca

(Labrusca, Vinifera)

In the middle of the last century, when grape-growing was in the hands of the connoisseurs, Rebecca was one of the sterling green varieties. It is wholly unsuited for commercial vineyards and for years has been disappearing gradually from cultivation. The fruit is exceptionally fine, consisting of well-formed bunches and berries, the latter handsome yellowish-

white and semi-transparent. In quality, the grapes are of the best, with a rich, sweet flavor and pleasing aroma. But the vine characters condemn Rebecca for any but the amateur. The vines lack in hardiness and vigor, are susceptible to mildew and other fungi and are productive only under the best conditions. The original vine was an accidental seedling found in the garden of E. M. Peake, Hudson, New York, and bore its first fruit in 1852.

Vine weak, sometimes vigorous, doubtfully hardy. Canes long, numerous, slender, dull brown, deepening in color at the nodes; tendrils continuous or intermittent, bifid or trifid. Leaves variable in size; upper surface dark green, dull, rugose; lower surface grayish-green, pubescent. Flowers self-fertile; stamens upright.

Fruit late mid-season, ships and keeps well. Clusters small, short, cylindrical, rarely with a small, single shoulder, compact. Berries of medium size, oval, green with yellow tinge verging on amber, thin gray bloom, persistent, firm; skin thin, without pigment; flesh pale green, very juicy, tender, melting, vinous, a little foxy, sweet; good to very good. Seeds free, short, narrow, blunt, brown.

Red Eagle

(Labrusca, Vinifera)

Red Eagle is a pure-bred seedling of Black Eagle which it resembles in all characters except color of fruit. Vine and fruit exhibit the characters found in Rogers' hybrids. It takes high rank as a grape of quality and can be recommended for the garden. The variety originated with T. V. Munson, Denison, Texas, and was sent out in 1888.

Vine medium in vigor and hardiness, productive. Canes few, slender, dark brown with heavy bloom; nodes prominent, flattened; tendrils continuous or intermittent, long, bifid. Leaves thick; upper surface light green, dull, rugose; lower surface grayish-green, pubescent; lobes three to five with terminus obtuse; petiolar sinus deep, narrow, sometimes closed and overlapping; basal sinus wide; lateral sinus deep, wide; teeth deep, wide. Flowers semi-fertile, late; stamens upright.

Fruit early mid-season, keeps well. Clusters small, broad, tapering, single-shouldered, sometimes double-shouldered, loose with many abortive berries; pedicel very long, slender; brush green with brown tinge. Berries variable in size, round, light to very dark red with heavy bloom, persistent, soft; skin thick, tender, adherent with some red pigment; flesh green, transparent, juicy, very tender, melting, slightly foxy, tart; very good. Seeds free, one to five, large, long, blunt, light brown.

Regal

(Labrusca, Vinifera)

Regal is an offspring of Lindley, which it greatly resembles. The fruit is attractive in appearance and high in quality. A seemingly insignificant fault might make Regal undesirable in a commercial vineyard; the clusters are borne so close to the wood that it is difficult to harvest the fruit and avoid injury to the berries next to the wood. The variety is worthy of extensive culture in vineyards and gardens. Regal originated with W. A. Woodward, Rockford, Illinois, in 1879.

Vine vigorous, hardy, healthy, very productive. Canes intermediate in length and size, numerous, dark reddish-brown. Tendrils intermittent, bifid or trifid. Leaves large; upper surface green, glossy and rugose; lower surface pale green with a bronze tinge, strongly pubescent. Flowers self-fertile, mid-season; stamens upright.

Fruit mid-season, keeps well. Clusters small, broad, cylindrical, usually with a short single shoulder, sometimes double-shouldered, very compact. Berries large, round, purplish-red with faint bloom, persistent. Skin thin, tough, without pigment. Flesh pale green, very juicy, fine-grained, tender, musky; good. Seeds free, numerous, long, narrow, notched, blunt with a short neck, brown.

Requa

(Labrusca, Vinifera)

This is one of Rogers' hybrids which equals other grapes of its color and season. The grapes are attractive in cluster and berry and are of very good quality but are subject to rot and

ripen too late for northern regions. The variety was named Requa in 1869, it having been previously known as No. 28.

Vine vigorous, hardy except in severe winters, medium in productiveness. Canes long, thick; tendrils continuous or intermittent, trifid or bifid. Leaves medium in size, dark green, often thick and rugose; lower surface grayish-green, pubescent. Flowers semi-fertile, late; stamens reflexed.

Fruit late, keeps long. Clusters large, cylindrical, often with a long, single shoulder, compact. Berries large, oval, dark, dull red covered with thin bloom, strongly adherent; skin thin, tough, adherent; flesh pale green, tender, stringy, vinous, foxy, sweet; good to very good. Seeds adherent, medium in size and length, broad, blunt.

Rochester

(Labrusca, Vinifera)

The fruit of Rochester is a large-clustered red grape, handsome and very good in quality. The vine is a strong grower, productive and free from diseases. The variety is difficult to propagate and, therefore, not in favor with nurserymen. The grapes are sweet, rich and vinous but should be used as soon as ripe, as they do not keep well and the berries quickly shatter from the bunch. As an attractive early red grape, Rochester is worth a place in the garden and in favored locations for a special market. Ellwanger and Barry, Rochester, New York, in 1867 grew Rochester from mixed seed of Delaware, Diana, Concord and Rebecca.

Vine vigorous, hardy, productive. Canes long, dark reddish-brown; nodes enlarged, flattened; internodes short; tendrils intermittent, long, bifid or trifid. Leaves large; upper surface light green, glossy, smooth; lower surface grayish-green, pubescent; lobes one to three with terminus acute; petiolar sinus deep; basal sinus absent; lateral sinus shallow; teeth shallow. Flowers fertile, mid-season; stamens upright.

Fruit does not keep well. Clusters large, broad, tapering, usually single-shouldered, compact; pedicel short, slender with few warts; brush slender, yellowish-brown. Berries medium, oval, purplish-red,

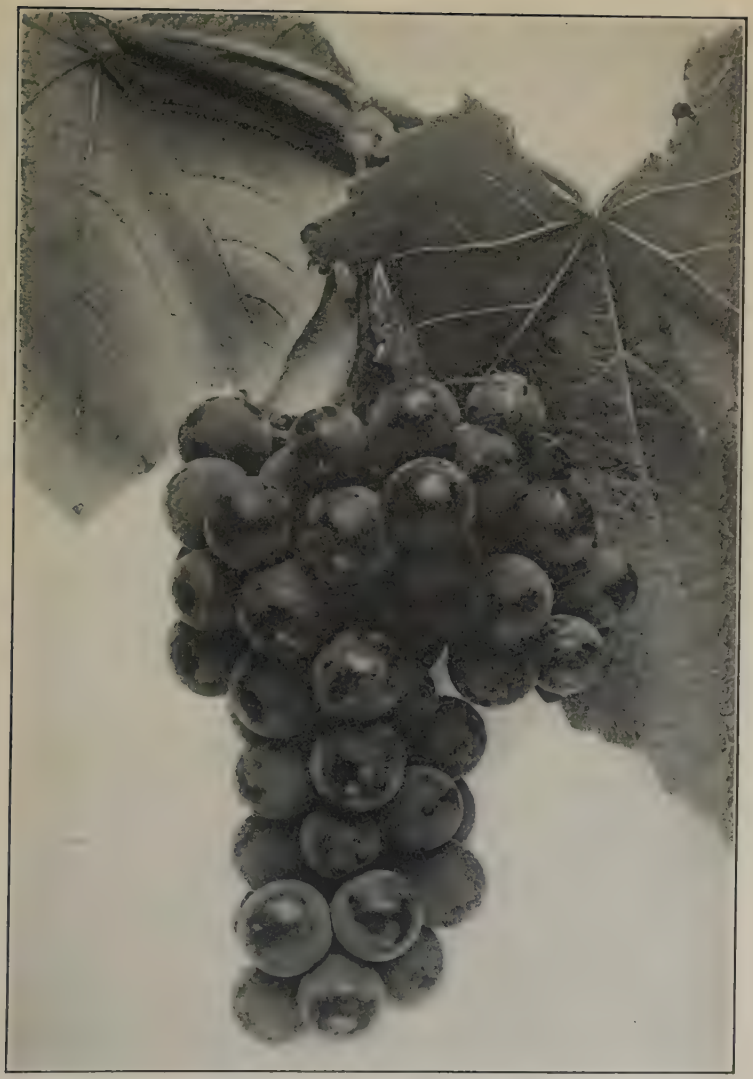

PLATE XXXII. — Wyoming ($\times \frac{2}{3}$).

dull with thin, lilac bloom, drop from the pedicel, soft; skin thick, tough, inclined to crack, free, without pigment, astringent; flesh pale green, transparent, juicy, tender, fine-grained, vinous, sweet; good to very good. Seeds free, one to three, large, short, broad, dark brown.

Rommel

(Labrusca, Vulpina, Vinifera)

Rommel is rarely cultivated in the North, because the vines lack in robustness, hardiness and productiveness and are susceptible to the leaf-hopper; and the grapes do not attain high quality and crack as they ripen. The bunch and berry are attractive in form, size and color. At its best, Rommel is a good table-grape and makes a fine white wine. It is worth growing in the South. T. V. Munson, Denison, Texas, originated Rommel in 1885, from seed of Elvira pollinated by Triumph, and introduced it in 1889.

Vine vigorous in the South. Canes long, numerous, thick, reddish-brown, surface roughened; nodes enlarged, often flattened; internodes short; tendrils intermittent, long, bifid or trifid. Leaves medium in size, round, thick; upper surface light green, dull, rugose; lower surface pale green, free from pubescence but slightly hairy; leaf not lobed, terminus acute to acuminate; petiolar sinus deep, narrow, often closed and overlapping; basal sinus lacking; lateral sinus shallow when present; teeth deep. Flowers semi-fertile, late; stamens upright.

Fruit mid-season, ships and keeps well. Clusters medium to short, broad, cylindrical, single-shouldered, compact; pedicel slender, smooth; brush short, pale green. Berries large, roundish, light green with a yellow tinge, glossy, persistent, firm; skin thin, cracks badly, tender, adherent, without pigment or astringency; flesh greenish, translucent, juicy, tender, melting, stringy, sweet; fair to good. Seeds free, one to four, broad, sharp-pointed, plump, brown.

Rosaki

(Vinifera)

Rosaki is a table- and raisin-grape of southeastern Europe and Asia Minor. According to some of the California nursery

companies, it is grown in that state under the name Dattier de Beyrouth, although it would seem from French descriptions that there is a separate, very late variety of the latter name. Rosaki is similar to Malaga and there is a possibility that in some of the warmer parts of the East, it may be grown commercially as a substitute for the latter. The variety seems to be little grown on the Pacific slope.

Vines vigorous, usually very productive. Leaves large, roundish, rugose, usually five-lobed; terminal lobe acuminate; petiolar sinus moderately deep to deep, medium broad; lower lateral sinus shallow, broad, occasionally lacking; upper lateral sinus shallow to medium, broad; margins broadly and bluntly dentate. Fruit ripens the third week in October, keeping qualities excellent; clusters large, loose, tapering, shouldered; berries large to very large, oval to long-oval, pale yellow-green; flesh translucent, tender, meaty, vinous, sprightly; quality good to very good.

Rose of Peru

(Vinifera)

Rose of Peru is a favorite table-grape in California, confused with and possibly the same as Black Prince. Its chief commendable characters are handsome appearance and high quality of fruit and very productive vines. It is not adapted for shipping and does not enter plentifully into commerce. Its season is so late that the variety is hardly worth trying in the East, and yet it has matured in favorable seasons at Geneva, New York. The following description is compiled:

Vine vigorous, healthy, productive; wood short-jointed, dark brown. Leaves of medium size; deep green above, lighter green and tomentose below. Bunches very large, shouldered, very loose, often scraggly; berry large, round, black with firm, crackling flesh; skin rather thin and tender; flavor sweet and rich; quality very good to best. Season late, keeping rather well but not shipping well.

Salem

(Labrusca, Vinifera)

Rogers' No. 22, Rogers' No. 53

Salem (Plate XXVII) is the one of Rogers' hybrids of which the originator is said to have thought most, and to which he gave the name of his place of residence. The two chief faults, unproductiveness and susceptibility to mildew, are not found in all localities, and in these districts, near good markets, Salem ought to rank high as a commercial fruit. The vine is hardy, vigorous and productive and bears handsome fruit of high quality. This variety was christened Salem by Rogers in 1867, two years earlier than his other hybrids were named.

Vine vigorous, hardy, variable in productiveness. Canes long, dark brown; nodes enlarged; tendrils continuous or intermittent, long, bifid or trifid. Leaves variable in size; upper surface dark green, dull; lower surface pale green with slight bronze tinge, pubescent; lobes one to three with terminus acute; petiolar sinus deep, narrow, often overlapping; basal sinus lacking; lateral sinus shallow, narrow, notched. Flowers sterile, mid-season; stamens reflexed.

Fruit early, keeps and ships well. Clusters large, short, broad, tapering, heavily shouldered, compact; pedicel short, thick with small warts, enlarged at point of attachment to berry; brush short, pale green. Berries large, round, dark red, dull, persistent, soft; skin thick, adherent, without pigment, astringent; flesh translucent, juicy, tender, stringy, fine-grained, vinous, sprightly; good to very good. Seeds one to six, large, long and broad, blunt, brown.

Scuppernong

(Rotundifolia)

American Muscadine, Bull, Bullace, Bullet, Fox Grape, Green Scuppernong, Green Muscadine, Hickman, Muscadine, Roanoke

Scuppernong is preëminently the grape of the South, the chief representative of the great species, *V. rotundifolia*, which

runs riot in natural luxuriance from Delaware and Maryland to the Gulf and westward from the Atlantic to Arkansas and Texas. Scuppernong vines are found on arbors, in gardens, or half wild, on trees and fences on nearly every farm in the South Atlantic states. As a rule, these vines receive little cultivation, are unpruned and are given no care of any kind; but even under neglect they produce large crops. The vines are almost immune to mildew, rot, phylloxera, or other fungal or insect pests; they give not only an abundance of fruit but on arbors and trellises are much prized for their shade and beauty. The fruit, to a palate accustomed to other grapes, is not very acceptable, having a musky flavor and a somewhat repugnant odor, which, however, with familiarity becomes quite agreeable. The pulp is sweet and juicy but is lacking in sprightliness. The grapes are not suitable for the market since the berries drop from the bunch in ripening and become more or less smeared with juice so that their appearance is not appetizing.

Vine vigorous, not hardy in the North, very productive. Canes long, numerous, slender, ash-gray to grayish-brown; surface smooth, thickly covered with small, light brown dots; tendrils intermittent, simple. Leaves small, thin; upper surface light green, smooth; lower surface very pale green, pubescent along the ribs; veins inconspicuous. Flowers very late; stamens reflexed.

Fruit late, ripens unevenly, berries drop as they mature. Clusters small, round, unshouldered, loose. Berries few in a cluster, large, round, dull green, often with brown tinge, firm; skin thick, tough with many small russet dots; flesh pale green, juicy, tender, soft, fine-grained, foxy, sweet to agreeably tart; fair to good. Seeds adherent, large, short, broad, unnotched, blunt, plump, surface smooth, brown.

Secretary

(Vinifera, Vulpina, Labrusca)

Injured by mildew and rot which attack leaves, fruit and young wood, the vines of Secretary are able to produce good grapes only in exceptional seasons and in favored localities.

The fruit characters of Secretary, however, give the grapes exceptionally high quality, the berries being meaty yet juicy, fine-grained and tender, with a sweet, spicy, vinous flavor. The bunches are large, well-formed, with medium-sized, purplish-black berries covered with thick bloom, making a very handsome cluster. While the vine and foliage somewhat resemble those of Clinton, one of its parents, the variety is not nearly as hardy, vigorous nor productive. Moreover, in any but favored localities in the North, its maturity is somewhat uncertain. These defects keep Secretary from becoming of commercial importance and make it of value only to the amateur. Secretary is one of the first productions of J. H. Ricketts, Newburgh, New York, the original vine coming from seed of Clinton fertilized by Muscat Hamburg, planted in 1867.

Vine vigorous, doubtfully hardy, variable in productiveness. Canes numerous, light brown, conspicuously darker at nodes, surface covered with thin, blue bloom; tendrils intermittent, bifid. Leaves small to medium, thin; upper surface light green, dull, smooth; lower surface pale green, glabrous. Flowers semi-fertile, early; stamens upright.

Fruit ripens after Concord, keeps and ships well. Clusters large, long, cylindrical with a large, single shoulder, often loose and with many abortive fruits. Berries large, round, flattened at attachment to pedicel, dark purplish-black, glossy, persistent, firm; skin tough with wine-colored pigment; flesh green, juicy, fine-grained, tender, vinous, sweet; good. Seeds free, large, broad, notched, long, dark brown.

Senasqua

(Labrusca, Vinifera)

The vine of Senasqua lacks in vigor, hardiness, productiveness and health. The grapes are of good quality, and when well grown are up to the average fruits of the Labrusca-Vinifera hybrids. Unfortunately the berries have a tendency to crack which is aggravated by the bunches being so compact as to crowd the berries. Senasqua is one of the latest grapes to open its buds and is, therefore, seldom injured by late frosts. It

can be recommended only for the garden for the sake of variety. Stephen W. Underhill of Crown Point, New York, originated Senasqua from seed of Concord pollinated by Black Prince.

Vine weak and tender, often unproductive. Canes short, few, reddish-brown; nodes enlarged, flattened; tendrils intermittent, long, trifid or bifid. Leaves light green, glossy, rugose; lower surface whitish-green, pubescent; leaf usually not lobed with terminus acute; petiolar sinus narrow; basal and lateral sinuses shallow and narrow when present. Flowers fertile, late; stamens upright.

Fruit a little later than Concord, keeps well. Clusters large, broad, irregularly tapering, usually with a small, single shoulder, very compact; pedicel thick, smooth, enlarged at point of attachment; brush short, reddish. Berries large, round, reddish-black, persistent, firm; skin thick, tender, cracks, adherent, contains some wine-colored pigment; flesh green, translucent, juicy, tender, meaty, vinous, spicy; good. Seeds free, one to five, long, narrow, one-sided, light brown.

Sultana

(Vinifera)

This variety was formerly the standard seedless grape in California for home use and raisins, but it is now outstripped by Sultanina. Sultana is possibly better flavored than Sultanina but the vines are hardly as vigorous or productive and the berries often have seeds. The description is compiled.

Vines vigorous, upright, productive. Leaves large, five-lobed, with large sinuses, light in color, coarsely toothed. Bunches large, long, cylindrical, heavily shouldered, sometimes not well filled, often loose and scraggly; berries small, round, firm and crisp, golden-yellow, sweet with considerable piquancy; quality good.

Sultanina

(Vinifera)

Thompson's Seedless

Sultanina is one of the standard seedless grapes of the Pacific slope, grown both to eat out of hand and for raisins. Probably

it can be grown in home plantations in favored parts of eastern America where the season is long and warm. The following description is compiled from Californian viticulturists:

Vine very vigorous, very productive; trunk large with very long canes. Leaves glabrous on both sides, dark yellow-green above, light below; generally three-lobed, with shallow sinuses; teeth short and obtuse. Bunch large, conico-cylindrical, well filled, with herbaceous peduncles; berries oval, beautiful golden-yellow color; skin moderately thick; flesh of rather neutral flavor; very good.

Taylor

(Vulpina, Labrusca)

Bullitt

While it is from the species to which Taylor belongs that we must look for our hardiest vines, nevertheless this grape and its offspring, although not tender to cold, do best in southern regions, as they require a long warm summer to mature properly. The quality of the fruit of Taylor is fair to good, the flavor being sweet, pure, delicate and spicy and the flesh tender and juicy; but the bunches are small and the flowers are infertile so that the berries do not set well, making very imperfect and unsightly clusters. The skin is such, also, that it cracks badly, a defect seemingly transmitted to many of the seedlings of the variety. The vine is strong, healthy, hardy but not very productive. The original vine of Taylor was a wild seedling found in the early part of the last century on the Cumberland Mountains near the Kentucky-Tennessee line by a Mr. Cobb.

Vine vigorous to rank, healthy, hardy, variable in productiveness. Leaves small, attractive in color, smooth. Flowers bloom early; stamens reflexed.

Fruit ripens about two weeks before Isabella. Clusters small to medium, shouldered, loose or moderately compact. Berries small to medium, roundish, pale greenish-white, sometimes tinged with amber; skin very thin; pulp sweet, spicy; fair to good in quality.

Triumph

(Labrusca, Vinifera)

When quality, color, shape and size of bunch and berry are considered, Triumph (Plate XXVIII) is one of the finest dessert grapes of America. At its best, it is a magnificent bunch of golden grapes of highest quality, esteemed even in southern Europe where it must compete with the best of the Viniferas. In America, however, its commercial importance is curtailed by the fact that the fruit requires a long season for proper development. Triumph has, in general, the vine characters of the Labrusca parent, Concord, especially its habit of growth, vigor, productiveness and foliage characters, falling short in hardiness, resistance to fungal diseases and earliness of fruit, the fruit maturing with or a little later than Catawba. While the vine characters of Triumph are those of Labrusca, there is scarcely a suggestion of the coarseness, or of the foxy odor and taste of Labrusca, and the objectionable seeds, pulp and skin of the native grape give way to the far less objectionable structures of Vinifera. The flesh is tender and melting and the flavor rich, sweet, vinous, pure and delicate. The skins of the berries under unfavorable conditions crack badly, the variety, therefore, neither shipping nor keeping well. Triumph was grown soon after the Civil War by George W. Campbell, Delaware, Ohio, from seed of Concord fertilized by Chassalas Musque.

Vine vigorous. Canes long, dark brown with much bloom; nodes enlarged; tendrils intermittent, long, trifid, sometimes bifid. Leaves large; upper surface light green, dull, rugose; lower surface grayish-white, pubescent; leaf usually not lobed with terminus obtuse; petiolar sinus deep, narrow, often closed and overlapping; basal sinus absent; lateral sinus shallow and narrow when present; teeth deep, wide. Flowers self-fertile, late; stamens upright.

Fruit very late. Clusters very large, long, broad, cylindrical, sometimes single-shouldered, compact; pedicel slender, smooth; brush short, yellowish-green. Berries medium in size, oval, golden yellow, glossy with heavy bloom, persistent, firm; skin thin, inclined to crack,

adherent, without pigment, slightly astringent; flesh light green, translucent, juicy, fine-grained, tender, vinous; good to very good. Seeds free, one to five, small, brown.

Ulster

(Labrusca, Vinifera)

The vines of Ulster set too much fruit in spite of efforts to control the crop by pruning; two undesirable results follow, the bunches are small and the vines, lacking vigor at best, fail to recover from the overfruitfulness. These defects keep the variety from becoming of importance commercially or even a favorite as a garden grape. The quality of the fruit is very good, being much like that of Catawba, and under favorable conditions it is an attractive green with a red tinge. The fruit keeps well when the variety is grown under conditions suited to it. Ulster originated with A. J. Caywood, Marlboro, New York, and was introduced by him about 1885. Its parents are said to be Catawba pollinated by a wild Æstivalis. Both vine and fruit show traces of Labrusca and Vinifera, but the Æstivalis characters, if present, are not apparent.

Vine hardy, productive, overbears. Canes short, slender, dark brown, surface roughened and covered with faint pubescence; nodes enlarged and flattened; internodes short; tendrils intermittent, bifid, dehisce early. Leaves small, thick; upper surface light green, glossy, smooth; lower surface grayish-white, pubescent; leaf usually not lobed with terminus acute; petiolar sinus medium to wide; basal sinus absent; lateral sinus a notch when present; teeth shallow, wide. Flowers self-fertile, early; stamens upright.

Fruit late mid-season. Clusters long, cylindrical, often single-shouldered, compact; pedicel slender, with numerous warts; brush short, yellowish-green. Berries medium in size, round, dark dull red with thin bloom, persistent; skin thick, tough, adherent, astringent; flesh pale green, translucent, juicy, tender, fine-grained, faintly aromatic, slightly foxy; good to very good. Seeds free, one to six, medium in size, plump, brown.

Verdal

(Vinifera)

Aspiran Blanc

Verdal is one of the standard late grapes of the Pacific slope, ripening among the last. The grapes are seen seldom in distant markets and the quality is not quite good enough to make it a very great favorite for home plantations. Vigor and hardiness of vines commend it as do the large and handsome fruits, and these qualities, with late ripening, will probably long keep it on grape lists in the far West. The description is compiled.

Vines vigorous, hardy, healthy and productive; canes rather slender, half erect. Leaves of medium size, glabrous on both surfaces, except below near the axis of the main nerve; sinuses well marked and generally closed, giving the leaf the appearance of having five holes; teeth long, unequal, acuminate. Bunches large to very large, irregular, long-conical, usually compact; shoulders small or lacking; berries large or very large, yellowish-green; skin thick but tender; flesh crisp, firm; flavor agreeable but not rich; quality good. Season very late, keeping and shipping well.

Vergennes

(Labrusca)

The most valuable attribute of Vergennes (Plate XXIX) is certainty in bearing. The vine seldom fails to bear although it often overbears, causing variability in size of fruits and time of ripening. With a moderate crop, the grapes ripen with Concord, but with a heavy load from one to two weeks later. Vergennes is somewhat unpopular with vineyardists because of the sprawling habit of the vines which makes them untractable for vineyard operations; this fault is obviated by grafting on other vines. The grapes are attractive, the quality is good, flavor agreeable, the flesh tender, and seeds and skin are not objectionable. Vergennes is the standard late-keeping grape

for northern regions, being very common in the markets as late as January. The original vine was a chance seedling in the garden of William E. Greene, Vergennes, Vermont, in 1874.

Vine variable in vigor, doubtfully hardy, productive, healthy. Canes long, dark brown; nodes enlarged, strongly flattened; tendrils continuous, long, bifid or trifid. Leaves large, thin; upper surface light green, glossy, rugose; lower surface pale green, very pubescent; leaf usually not lobed with terminus broadly acute; petiolar sinus wide; teeth shallow. Flowers semi-sterile, mid-season; stamens upright.

Fruit late, keeps and ships well. Clusters of medium size, broad, cylindrical, sometimes single-shouldered, loose; pedicel with numerous small warts; brush slender, short, pale green. Berries large, oval, light and dark red with thin bloom, persistent; skin thick, tough, adherent, astringent; flesh pale green, juicy, fine-grained, somewhat stringy, tender, vinous; good to very good. Seeds free, one to five, blunt, brown.

Walter

(Vinifera, Labrusca, Bourquiniana)

Were it not almost impossible to grow healthy vines of Walter, the variety would rank high among American grapes. But stunted by fungi which attack leaves, young wood and fruit, it is possible only in exceptionally favorable seasons satisfactorily to produce crops of this variety. Besides susceptibility to diseases, the vines are fastidious to soils, everywhere variable in growth and are injured in cold winters. As if to atone for the faults of the vine, the fruit of Walter is almost perfect, lacking only in size of bunch and berry. The bunch and berry resemble those of Delaware, but the fruit is not as high in quality as that of its parents. Walter is adapted to conditions under which Delaware thrives. A. J. Caywood, Modena, New York, grew this variety about 1850 from seed of Delaware pollinated by Diana.

Vine vigorous. Canes medium in length and size, dark reddish-brown with thin bloom; nodes enlarged, flattened; tendrils intermittent, bifid. Leaves thick; upper surface dark green, glossy, smooth;

lower surface tinged with bronze, heavily pubescent; lobes one to three with terminus acute; petiolar sinus narrow; basal sinus lacking; lateral sinus a notch if present. Flowers mid-season; stamens upright.

Fruit early, keeps and ships well. Clusters medium in size, broad, cylindrical, usually single-shouldered, compact; pedicel slender, with small, scattering warts; brush short, slender, green with brown tinge. Berries small, ovate, red, glossy with thin bloom, persistent, firm; skin very tough, adheres slightly, unpigmented; flesh pale green, translucent, juicy, tough, somewhat foxy, vinous, aromatic; good to very good. Seeds adherent, one to four, small, sharp-pointed, light brown.

WILDER

(Labrusca, Vinifera)

The fruit of Wilder is surpassed in quality and appearance by other of Rogers' hybrids, but the vine is the most reliable of any of these hybrid sorts, being vigorous, hardy, productive, and, although somewhat susceptible to mildew, as healthy as any. Wilder is not as well known in the markets as it should be, and now that fungal diseases can be controlled by spraying should be more commonly planted in commercial vineyards, especially for local markets. Wilder is one of the forty-five Labrusca-Vinifera hybrids raised by E. S. Rogers, Salem, Massachusetts, having been described first in 1858.

Vine vigorous, hardy, productive, susceptible to mildew. Canes long, numerous, reddish-brown, darker at the nodes; internodes long; tendrils intermittent, bifid or trifid. Leaves large, irregularly round; upper surface dark green, glossy, smooth; lower surface pale green, pubescent; usually not lobed with terminus acute; petiolar sinus deep, narrow, often closed and overlapping; basal sinus lacking; lateral sinus shallow, narrow, or a mere notch when present. Flowers self-sterile, mid-season; stamens reflexed.

Fruit early mid-season, keeps and ships well. Clusters variable in size, short, broad, tapering, heavily single-shouldered, loose; pedicel long, thick with numerous warts; brush thick, green with tinge of red. Berries large, oval, purplish-black with heavy bloom, persistent, firm; skin thick, adherent to pulp, with bright red pigment, astringent; flesh green, translucent, juicy, tender; good. Seeds adherent, one to five, long, light brown.

Winchell

(Labrusca, Vinifera, Æstivalis)

Green Mountain

The vines of Winchell (Plate XXX) are vigorous, hardy, healthy, productive, and the fruit is early, of high quality and ships well—altogether a most admirable early grape. There are some minor faults which become drawbacks in the culture of Winchell. The berries, and under some conditions the bunches, are small and the bunch is loose with a large shoulder. Sometimes this looseness becomes so pronounced as to give a straggling, poorly-formed cluster; and the shoulder, when as large as the cluster itself, which often happens, makes the cluster unsightly. The grapes shell when fully ripe, a serious fault. Again, while the crop usually ripens evenly, there are seasons when two pickings are needed because of the unevenness in ripening. Lastly, the skin is thin and there is danger in unfavorable seasons of the berries cracking, although this is seldom a serious fault. These defects do not offset the several good characters of Winchell which make it the standard early green grape, deserving to rank with the best early grapes of any color. The original vine was raised by James Milton Clough, Stamford, Vermont, about 1850 from seed of an unknown purple grape.

Vine vigorous, hardy, healthy, very productive. Canes long, numerous, slender, dark brown with thin bloom; nodes enlarged, flattened; tendrils continuous, sometimes intermittent, bifid. Leaves large; upper surface light green, glossy, smooth; lower surface dull green, tinged with bronze, faintly pubescent; lobes three to five with terminal lobe acute; petiolar sinus deep; basal sinus shallow; teeth shallow, wide. Flowers fertile, mid-season; stamens upright.

Fruit early, keeps and ships well. Clusters long, slender, cylindrical, often with a long shoulder, compact; pedicel short, slender with few inconspicuous warts; brush greenish-white. Berries small, round, light green, persistent, soft; skin marked with small, reddish-

brown spots, thin, tender, slightly astringent; flesh green, translucent, juicy, tender, fine-grained, sweet; very good to best. Seeds free, one to four, small, plump, wide and long, blunt, brown.

Woodruff

(Labrusca, Vinifera?)

Woodruff is a handsome, showy, brick-red grape with large clusters and berries, but its taste belies its looks, for the flesh is coarse and the flavor poor. The variety would not be worth attention were it not for its excellent vine characters; the vines are hardy, productive and healthy. The grapes ripen a little before Concord and come on the market at a favorable time, especially for a red grape. Woodruff originated from C. H. Woodruff, Ann Arbor, Michigan, as a chance seedling which came up in 1874 and fruited first in 1877.

Vine very vigorous, hardy. Canes dark brown; nodes enlarged, flattened; tendrils continuous, bifid or trifid. Leaves round; upper surface light green, dull, rugose; lower surface greenish-white, pubescent; leaf usually not lobed with terminus acute; petiolar sinus wide; basal sinus lacking; lateral sinus shallow and narrow when present; teeth shallow. Flowers semi-fertile, early; stamens upright.

Fruit ripening before Concord. Clusters broad, widely tapering, usually single-shouldered, compact; pedicel short, thick, smooth; brush long, pale green. Berries large, round, dark red, dull, firm; skin thin, tender, adherent, slightly astringent; flesh pale green, translucent, juicy, tough, coarse, very foxy; fair in quality. Seeds adherent, one to five, broad, short, plump, blunt, brown.

Worden

(Labrusca)

Of the many offspring of Concord, Worden (Plate XXXI) is best known and most meritorious. The grapes differ chiefly from those of Concord in having larger berries and bunches, in having better quality and in being a week to ten days earlier.

The vine is equally hardy, healthy, vigorous and productive but is more fastidious in its adaptations to soil, although now and then it does even better. The chief fault of the variety is that the fruit cracks badly, often preventing the profitable marketing of a crop. Besides this tenderness of skin, the fruit-pulp of Worden is softer than that of Concord, there is more juice, and the keeping qualities are not as good, so that the grapes hardly ship as well as those of the more commonly grown grape. Worden is very popular in northern grape regions both for commercial plantations and the garden. It is a more desirable inhabitant of the garden, because of higher quality of fruit than Concord, and under conditions well suited to it is better as a commercial variety, as the fruit is handsomer as well as of better quality. In the markets the fruit ought to sell for a higher price than Concord if desired for immediate consumption, and if it can be harvested promptly, as it does not hang well on the vines. Its earlier season is against it for a commercial variety and, with the defects mentioned, will prevent its taking the place of Concord to a great degree. Worden was originated by Schuyler Worden, Minetto, Oswego County, New York, from seed of Concord planted about 1863.

Vine vigorous, hardy, healthy, productive. Canes large, thick, dark brown with reddish tinge; nodes enlarged, flattened; tendrils continuous, slender, bifid, sometimes trifid. Young leaves tinged on the under side and along the margins of upper side with rose-carmine. Leaves large, thick; upper surface dark green, glossy, smooth; lower surface light bronze, pubescent; leaf usually not lobed; petiolar sinus wide, often urnshaped; teeth shallow. Flowers fertile, mid-season; stamens upright.

Fruit early. Clusters large, long, broad, tapering, usually single-shouldered, compact; pedicel slender with a few small warts; brush long, light green. Berries large, round, dark purplish-black, glossy with heavy bloom, firm; skin tender, cracks badly, adheres slightly, contains dark red pigment, astringent. Flesh green, translucent, juicy, fine-grained, tough, foxy, sweet, mild; good to very good. Seeds adherent, one to five, large, broad, short, blunt, brown.

Wyoming

(Labrusca)

Hopkins Early Red, Wilmington Red, Wyoming Red

Such value as Wyoming (Plate XXXII) possesses lies in the hardiness, productiveness and healthiness of the vine. The appearance of the fruit is very good, the bunches are well formed and composed of rich amber-colored berries of medium size. The quality, however, is poor, being that of the wild Labrusca in foxiness of flavor and in flesh characters. It is not nearly as valuable as some other of the red Labruscas hitherto described and can hardly be recommended either for the garden or the vineyard. Wyoming was introduced by S. J. Parker of Ithaca, New York, who states that it came from Pennsylvania in 1861.

Vine vigorous, hardy, healthy, productive. Canes numerous, slender, dark reddish-brown covered with blue bloom; nodes enlarged, frequently flattened; tendrils continuous, short, bifid. Leaves of average size and thickness; upper surface light green, dull, smooth; lower surface dull green with tinge of bronze, pubescent; lobes one to three with terminus acute; petiolar sinus shallow, wide; basal sinus usually wanting; lateral sinus shallow and wide when present; teeth shallow. Flowers sterile, mid-season; stamens reflexed.

Fruit early, keeps well. Clusters slender, cylindrical, compact; pedicel short, slender with small warts; brush slender, pale green with brown tinge. Berries medium, round, rich amber red with thin bloom, persistent, firm; skin tender, adherent, astringent; flesh pale green, translucent, juicy, tough, solid, strongly foxy, vinous; poor in quality. Seeds adherent, one to three, slightly notched, light brown.

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